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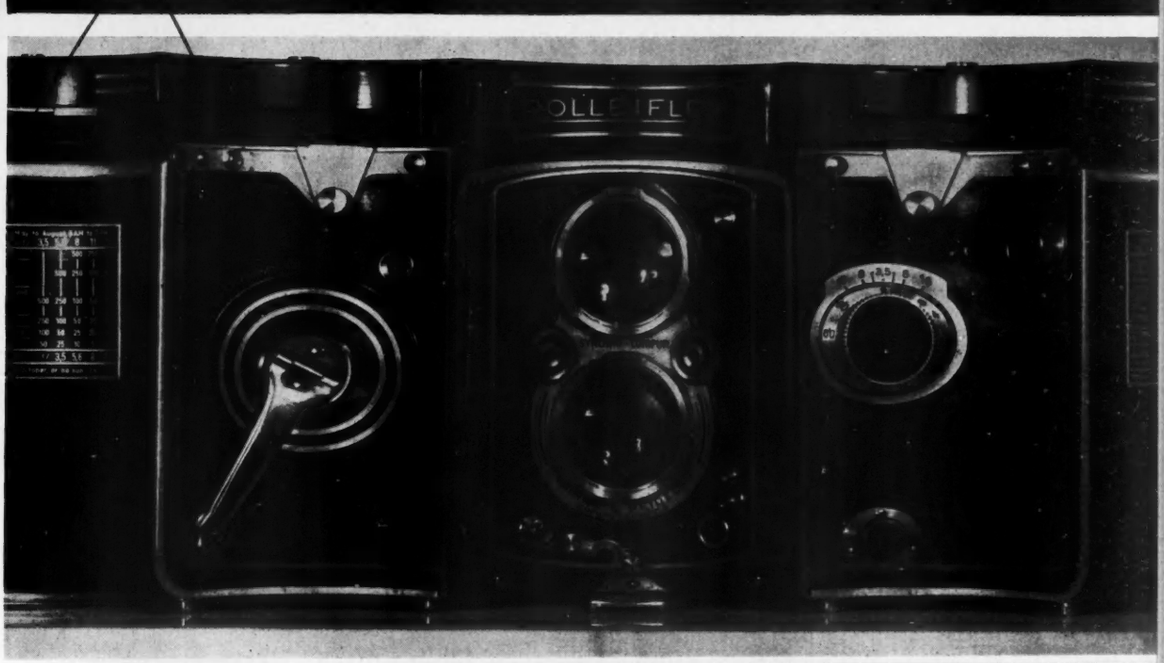

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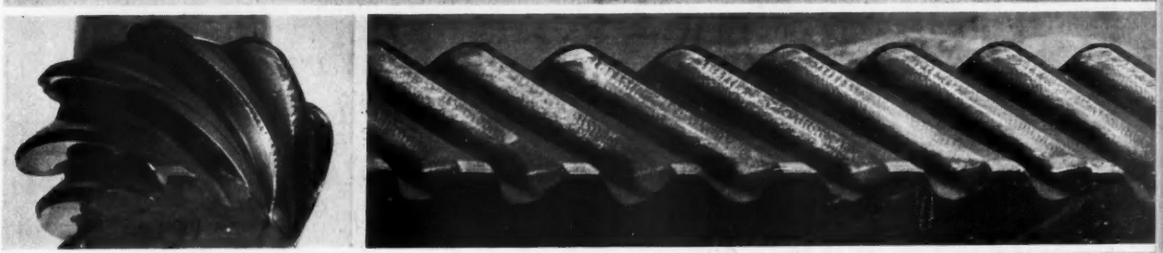

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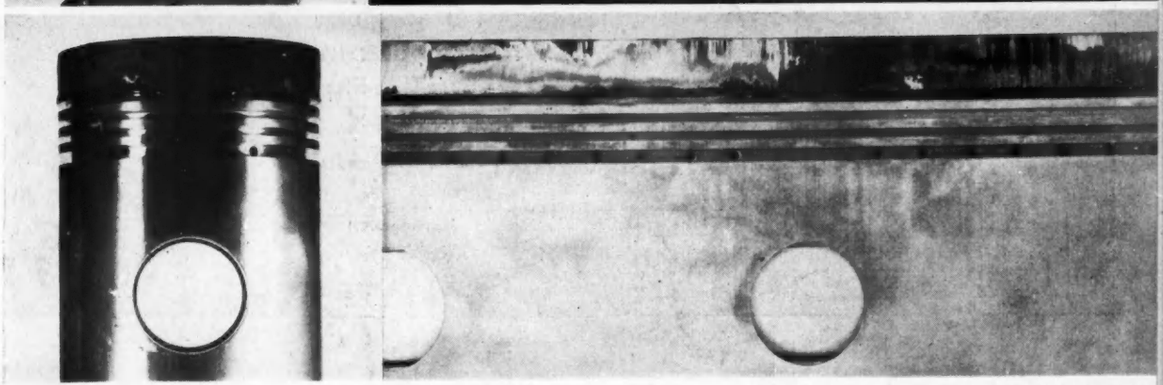

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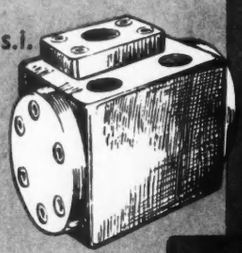

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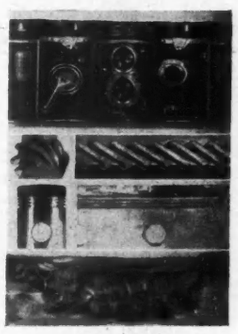

Cover Picture

The cover picture is four examples of the photographs that can be taken with a new "peripheral" camera developed by the Thornton Research Centre of "Shell" Research Limited to photograph cylindrical and other round surfaces. The camera is described in detail in the article on pages 98 to 100.

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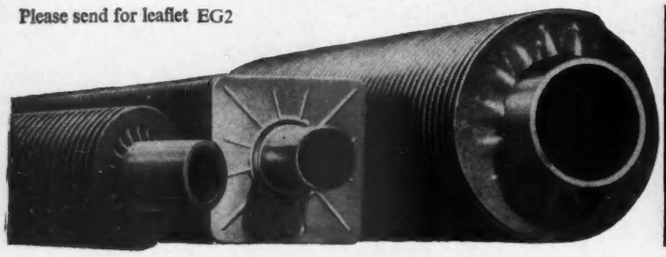

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Aug. 15	Machine Tools and Miscellaneous stores including:	W.D. Storage Depot, Rotherwas, Hereford	Russell Baldwin & Bright (Dept. J), 20 King Street, Hereford. (Tel. 4366)
	Morey, Keighley, Atlas, Southbend, Rivett, Myford, and other Lathe; Bamkin, Gatti, Le Blond, Newall, Wolf and other Grinders; Milwaukee, Ward Haggas & Smith, Victoria, Atlas and Black & Decker Millers; Herbert, Pollard and Jones & Shipman Drilling machines; guillotines; welding plants; wood working machines; shaper; air compressors; fourway portable conveyors; tyres; 11,000 blankets; 14,500 greatcoats; Pel stacking and other chairs; steel wardrobes; tables and miscellaneous furniture and kitchen equipment; motor alternator units and other radar equipment; electrical and wireless spares; electric cable and self-winding cable reels; M.T. and Aircraft spares; etc.		
Aug. 24	Vehicles, Machine Tools and Miscellaneous stores	W.D. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire	Dixon & Wallace Ltd. (Dept. J), Bank Buildings, Graham Square, Glasgow, E.1 (Tel.: Bridgeton 2447)
Aug. 29	Miscellaneous stores	W.D. Storage Depot, Royal Arsenal, Woolwich, London S.E.18	Fuller, Horsey, Sons & Cassell (Dept. J), 10 Lloyd's Avenue, London, E.C.3 (Tel.: Royal 4861)
Sept. 5	Machine Tools and Miscellaneous stores, including:	W.D. Storage Depot, South West Stores, Euxton Lane, Chorley, Lancs. (Sale at Cheetham Town Hall, Manchester, 8)	J. H. Norris & Son (Dept. J), 9 Albert Square, Manchester 2 (Tel.: Blackfriars 8373)

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ENGINEERING Impact

of the Emphasis on the Heavyweights

IN THE immediate future one of the effects of Mr. Selwyn Lloyd's 7 per cent Bank Rate, and of credit being made "more expensive and more difficult to get," may be a reduction in the contribution that small expanding firms are able to make to the total of British exports.

Before the trade crisis reached its present critical level there was widespread effort around the provinces as local manufacturers formed export groups and followed the Prime Minister's exhortation that the medium firms should emulate the export activity of the industrial giants.

For the medium and small firm the greater difficulties of raising money, and its higher cost when they have, will mean that the risks of export promotion will loom more blackly, that the ICI's and the AEI's of industry will be left with a heavier share of the responsibiiity.

How long the 7 per cent Bank Rate will apply remains to be seen. While it lasts, the tendency for promising young firms, with new ideas and the advantage of direct leadership by those with first hand ownership and inspiration, to be absorbed by bigger, more complex groups, with the golden advantage of their own resources, will speed up and spread.

This may be good for the groups doing the absorbing. But it may equally remove some of the gusto with which the new ideas were being developed, and certainly limit the scope of their application from all industry to one group.

Strangling the promising infant companies, producing its obvious effect on the rate of industrial investment, the new Bank Rate is plainly a desperate remedy for a critical situation. For those who were expecting steps to expand production, there is only disappointment.

High Flying Executives

HAS your factory its own airstrip? Some of the swiftest growing engineering concerns in the United Kingdom do have their own facilities for operating business aircraft, like the Pressed Steel company. Many others are aware of the need to waste as little executive time as possible, and private flying is one proved way of adding to the effectiveness of the executive team.

So long as it is realised that a business aircraft can no more compete with a Comet 4B on the London-Rome route than a saloon car can beat the Royal Scot, the private plane has many advantages. As listed by Mr. E. W. Pasold, one of the leading spirits of the Business Aircraft Users' Association, on the occasion of the Association's recent first general meeting, these are:

Greater speed than airlines or trains, cross-country freedom from timetables, no advance bookings and freedom to change plans at short notice.

Forty industrial firms founded the Business Aircraft Users' Association some two months ago and already this energetic new "voice of the industry" has a number of vigorous campaigns in hand. One is for business aerodromes and for the provision of aerodrome facilities at all principal towns and cities in Britain.

Lack of adequate Customs facilities at the aerodromes available to the executive flier is believed to be one of the factors holding back the full utilisation of business aircraft in the export efforts of industry. The Association is seeking the improvement of these arrangements and also the granting of handling facilities for its members at airports in Europe and the Middle East.

Whether or not Britain is admitted to the European Common Market this year or at some future date, more and more British firms are finding themselves European links. Executive flying for them has obvious attractions. Within the United Kingdom, where the same company may have factories, to say nothing of important customers, in England, Wales and Scotland, much needed improvements in efficiency can be helped forward by bringing the management into easier contact with the widespread empire.

And there is a lucrative export market in the sale of executive and personal aircraft stretching into the future.

Speeding Up the Main Line

WITH the start of the Winter Timetable next September, the Eastern Region makes another spectacular effort towards increasing main line train speeds under the railway modernization plan. The route affected is the main line from King's Cross to the north, and 22 new Deltic diesel locomotives will be responsible for the planned accelerations.

The accelerated trains will help to remove the criticism sometimes levelled at British Railways that journey times between London and some important business centres are longer than they were 50 years ago. The two pre-war fliers over this route presented operating difficulties due to the problem of finding a path for them among the frequent much slower trains. A better service to the public, in particular the businessman struggling to keep an appointment in a distant city, is likely to result from a general speed-up.

Such an acceleration is less of a headache to the Operating Department, but presents the difficulty of guaranteeing suitable motive power, having in mind the unavoidable disparity between train loadings. At 3,300 hp apiece, the new Deltics are the most powerful single-unit diesel locomotives in the world, and they will be rostered for the faster, heavier trains. Basing a timetable on Deltics will mean that in the event of a failure before the start of a run, another of the same class must be available or the timekeeping of not one but several trains is likely to be thrown out of gear. It is therefore intended that out of the 22 Deltics to be shared between the Eastern, North Eastern and Scottish Regions, two will normally be kept as standby when the new timetable comes into effect.

In the course of a recent test run from Kings Cross to Leeds and back with a 12 coach train, one of the new locomotives found itself easily capable of doing the 185¼ mile single journey in 3 hours with one stop, even allowing for certain temporary and permanent speed restrictions. With memory of the ill-fated Glasgow suburban electrification in mind, it is to be hoped that any teething troubles with the new locomotives will have been rectified before September so that the service improvement shown on paper straightaway becomes an accomplished fact.

of Where the (Export) Going is Good

WHATEVER else it is about the export markets that contributes to the poor showing of the United Kingdom it is not lack of opportunities. In the United States, where in the past British exports have earned great sums, and in Western Germany with its abounding potential, prospects for the British exporter are good (Western Germany) and improving (USA).

These estimates are made in the London School of Marketing's *Export Guide*, which is in direct descent from the General Electric Company's publication of the same name.

The guide lists 19 countries with good prospects, three where things are looking up—in addition to the USA these are Argentina and Iraq—and only two where prospects are bad, Ceylon and Venezuela. The longer list of territories where conditions are deteriorating serve to show how ready the manufacturing industries have to be to shift the main weight of their efforts to less traditional parts of the world market. Australia, New Zealand and South Africa have all established substantial positions as importers of English made manufactured goods, themselves earning the capital for these purchases with heavy sales of various raw materials and foodstuffs to this country.

Now, along with Rhodesias and Nyasaland, Iran and Kenya, these three countries appear in the LSM Export Guide among those whose export chances for British goods are going down.

The major nations of the European Common Market are good prospects for our exports. Only Belgium is an exception, as in the last quarters report, opportunities there are deteriorating. France, Italy, West Germany and the Netherlands all have good prospects.

American Improvement

In its commentary accompanying the facts and figures of the guide, the London School of Marketing roundly declares, "inadequate marketing techniques, broken delivery dates, lack of knowledge of the market have been much more important deterrents than prices in hindering the promotion of exports."

The LSM point to something rather more than a gleam of hope in improving conditions in United States industrial activity. Of the total fall of £429 million in Britain's balance with non-sterling countries last year, £276 million was due to the sharp fall in exports to the United States. Some of this may be a permanent change. It is hard to see how British car manufacturers are going to win back their high sales figures in North America now that the gap has been plugged with the "compact" car. But if as much as a third of this total fall is put down to major changes of this sort in the market it still leaves a sizeable amount of room in which the exporters can manoeuvre to recover the position.

On the question of exporting cars to the United States Mr. F. J. Erroll, Minister of State at the Board of Trade, recently back from a North American tour, reported that agents there have "every hope" of improvement in the total volume of British car sales across the Atlantic. The important point about this will be how large the improvement will be.

Mr. Erroll believes there is too much talk about agents. Although direct representation is expensive it is much the better method and can pay for itself many times over.

and Wide Recognition for Diploma in Technology

IN ONE of the more bleak periods in the country's progress it is reasonable to be restrainedly optimistic at the annual report of the National Council for Technological Awards.

The Report covers the year April, 1960, to March, 1961. In that period almost 5,000 students were taking courses in the Diploma in Technology, against 3,800 a year earlier. Some 1,500 students had enrolled in the first year courses in the previous year—in the period under review this had risen to 1,770, including 63 women.

It is evident that both industry and the colleges concerned have taken up the idea of the Diploma in Technology with enthusiasm and one of the most encouraging aspects of this side of technical education, in addition to the extra output of trained technologists, is the speed and flexibility in which educational institutions and staff have adapted to a new situation.

About 83 per cent of engineering students and 56 per cent of the students of technologies other than engineering were industry based. That means that the student is normally a student-apprentice selected by a firm, in collaboration with the college, who is paid full wages over the whole period including academic terms. The college based student is selected by the college and normally financed by the Local Education Authority or a State Scholarship.

The widespread recognition won by the Diploma is also encouraging. The scientific Civil Service now accepts the Dip.Tech. on an equal footing with a university degree. The Burnham technical committee recognize the Dip.Tech. holder as eligible for a graduate addition to his salary. Most professional institutions exempt Diploma holders from their Institute's examination for graduate membership.

One further development has been the decision of the Vice-Chancellors and Principals that universities should treat Diplomatists equally with university graduates. This has meant that a number of holders of the Diploma, financed by DSIR grants, are reading at universities for higher degrees. In the opposite direction a number of university graduates are registered as candidates for the Membership of the College of Technologists.

There are undoubtedly important correctives to be applied to major sectors of the United Kingdom economy. But it is worth applauding one of the success stories in training for industry.

A New Camera to Photograph Peripheries

A camera for photographing the curved surfaces of cylinders and irregular objects has been developed by "Shell" Research Limited.

THE deposits which form in an internal combustion engine affect its reliability and overhaul life; crankcase sludge can dam the oil flow, and ring groove deposits can prevent the piston rings sealing the cylinder bores. Since deposit formation depends largely on the properties of the fuel and lubricant used, it must be measured when improved fuels and lubricants are being developed. By far the most satisfactory record of the appearance of the different engine parts is made by photography. Only in this way can the location and texture of deposits be recorded.

The photography of oily, shiny pistons, however, is particularly difficult. There is a very great difference between the intensity of illumination of the bottom of the piston ring grooves (where essential detail must be recorded) and of the polished skirt. Specular reflections make it difficult to photograph scratches and wear marks on the latter.

A way of photographing pistons is to use one of the cameras[1,2,3,4,5] that have been designed for photographing the curved surfaces of cylindrical objects. These build up the picture of the curved surface a strip at a time. As the strip which is being photographed is always viewed normally, it is possible to use oblique illumination to emphasize surface texture.

Periphery cameras have other advantages too. The whole of the curved surface of a piston may be recorded on one negative and the skirt area covered by deposit may be measured just as if the skirt had been unrolled. The colour of lacquer changes with viewing angle, but in periphery cameras the cylindrical surface is always viewed normally. Hence, a colour photograph of a lacquered piston taken by one of these cameras is not confused by the effect of the variable angle of view.

The Thornton Research Centre of "Shell" Research Limited has used a periphery camera of Luck's design for several years. This particular design[2,3] had two limitations, firstly it could only accept cylinders between 2 and 6 in in diameter, secondly it could not photograph objects which departed far from the pure cylindrical form.

It was therefore decided to design a new camera which would not be so restricted in its application. This article describing the camera and its background is based on an internal paper by F. Fox, G. K. Ashbury and J. W. Drinkwater of "Shell" Research Limited, Thornton Research Centre, P.O. Box 1, Chester.

The Principle

The requirements to be satisfied by the new camera were as follows:

(1) It should be capable of photographing cylindrical objects whose diameters differ widely. (2) It should be capable of photographing internal as well as external cylindrical surfaces. (3) It should be capable of photographing objects whose form is appreciably different from that of a pure cylinder. (4) It should be possible to illuminate the object in any way that is desired, i.e., without being limited by interference by the camera mechanism.

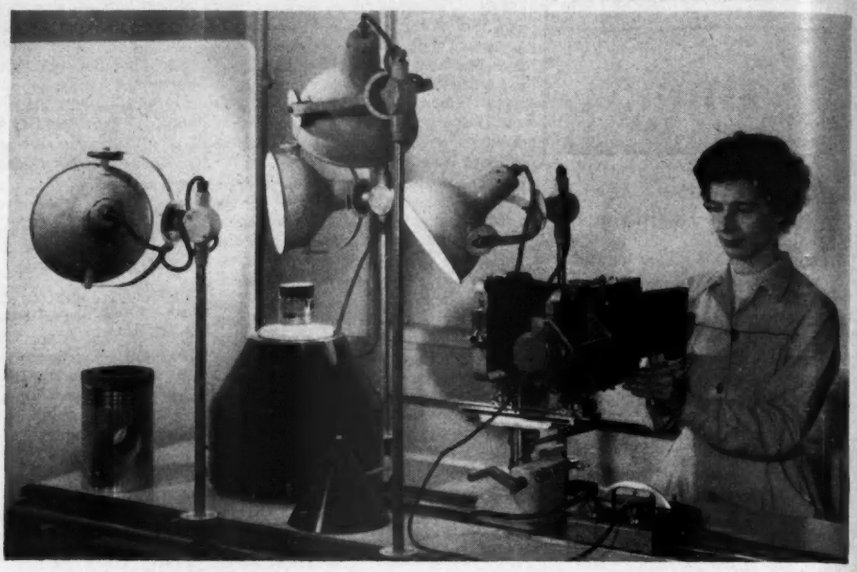


Fig. 1 The camera set up on its bench which provides location for its three parts: the turntable, the camera and the control unit. The operator is inserting a film holder in the traversing back.

In order to build in the flexibility implied by these requirements the new periphery camera was designed as two separate units, namely, (*a*) a rotating table whose purpose was to bring each strip of the cylinder in turn on to the centre line of the camera. (*b*) a camera embodying a mechanism to move a photographic plate behind a stationary slit, in step with the image of the rotating cylinder.

The control of the speed of rotation of the table and of the speed of translation of the photographic plate was achieved by driving both the table and the camera mechanism by synchronous motors running off a common 50 c/s supply. The periphery camera was completed by a control unit whose function was to start and stop the table and the plate traverse mechanism.

The essentials of the apparatus are shown in plan in Fig. 2.

O is a cylindrical object of radius r which is placed on the turntable and is rotated by it. Distance u from the nearest point of the cylinder is lens L. It forms an image of the nearest part of the cylinder at distance v, where is located photographic plate P. Immediately in front of the plate is a narrow slit S. Thus the plate "sees" only a narrow central strip of the cylinder. As the cylinder rotates anti-clockwise, its image moves (downwards in the diagram). The photographic plate has a fixed traverse t which it performs while the object rotates once. In order to produce a sharp picture, the image of the rotating cylinder must keep in step with the movement of the plate. There is a unique magnification $\left(\frac{v}{u}\right)$ which will satisfy this requirement:

The circumference of the cylinder is $2\pi r$.

So the image of its circumference has a length

$$2\pi r \frac{v}{u}$$

This must be equal to the traverse of the plate, t,

$$\text{i.e.,} \qquad 2\pi r \frac{v}{u} = t \text{ or } \frac{v}{u} = \frac{t}{2\pi r} \quad \ldots \quad (1)$$

Thus the magnification to be used is inversely proportional to the diameter of the object.

The new periphery camera has been built to suit an existing photographic bench. Equation (1) has therefore been put in the form of graphs which relate the camera track calibration (distance u in Fig. 2) to the diameter of the cylinder to be photographed. A separate graph is needed for each focal length of lens used in the camera. The procedure is to set the position of the camera from the appropriate graph and then focus in the normal way. The rotating table is always put in the same position on the bench.

The periphery camera has been designed to photograph internal as well as external cylindrical surfaces, such as ball and roller races, and half bearings. This is done by reversing the direction of rotation of the table and focusing on the most distant rather than on the nearest part of the surface.

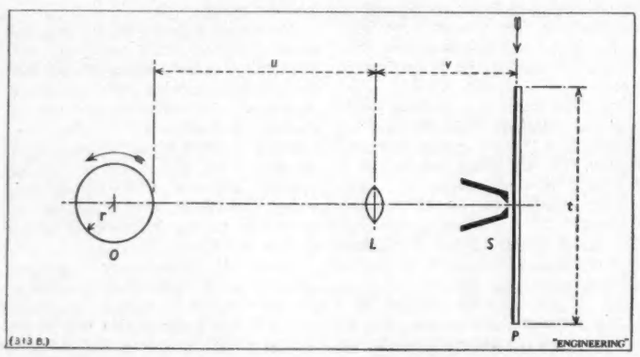
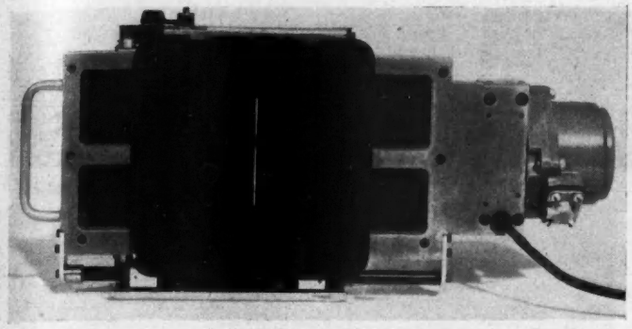


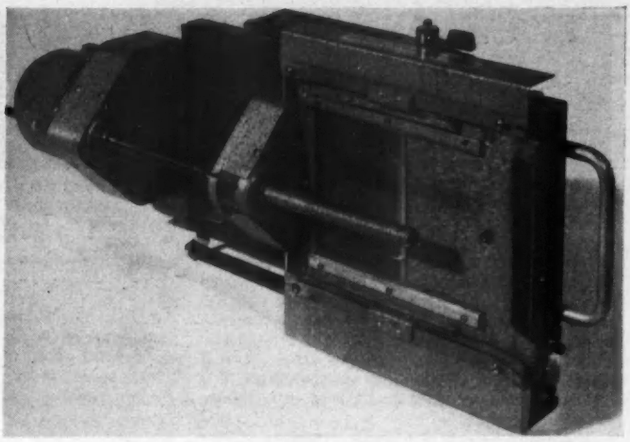
Fig. 2 Diagrammatic plan of the periphery camera set up to photograph the outside of a cylinder.

Objects Which Are Not True Cylinders

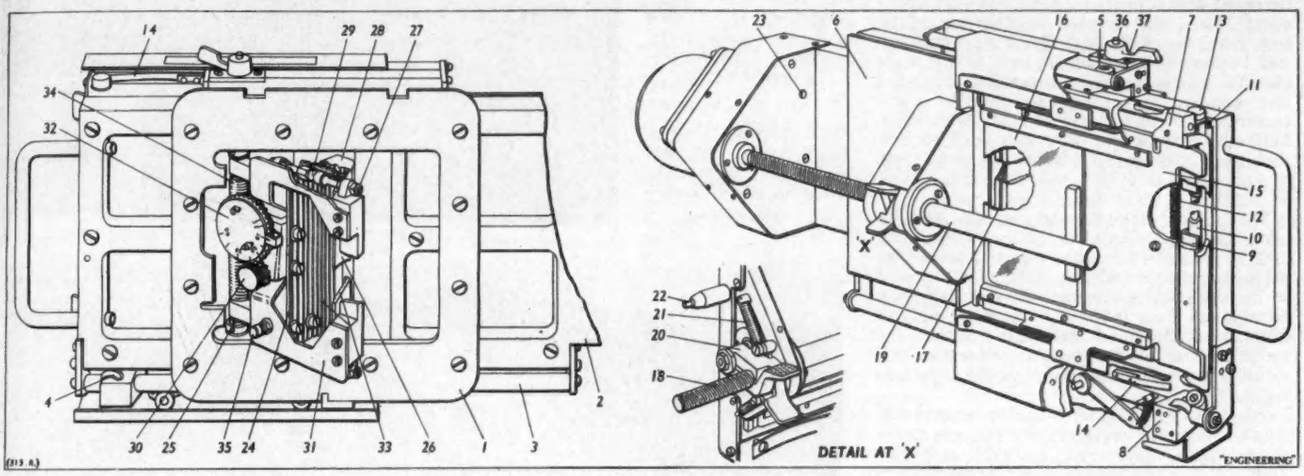
The piston which we have considered as a typical engine component is not a true geometrical cylinder. The skirt and the piston ring lands are parts of one cylindrical surface, while the grooves are part of a smaller, coaxial one.

Let the width of the slit S in Fig. 2 be s.





Figs. 3, 4 and 5 The camera-back satisfies three requirements: (a) moves the film uniformly along a straight track, (b) is light-tight despite its moving parts, (c) incorporates an adjustable slit which is removable for focusing. Fig. 3 (above) shows the rear view, Fig. 4 (right) the front view and Fig. 5 (below) the various component parts.



In the time that the image of a smaller cylinder takes to traverse the slit, the image of a larger cylinder will move $s\frac{R}{r}$.

Thus the length of the line of confusion will be

$$s\frac{R}{r} - s = \frac{s(R-r)}{r} = s\frac{\delta r}{r} \quad (2)$$

In order to produce sharp photographs of objects which depart appreciably from the truly cylindrical form, it is necessary to expose the plate through a very narrow slit. This requirement has been kept in mind in the design of the new periphery camera, and has resulted in an apparatus which will photograph objects which are substantially different in shape from geometrical cylinders.

Fig. 1 shows the new periphery camera set up on the photographic bench which provides mechanical locations for its three parts, the turntable, the camera, and the control unit.

Turntable

The turntable has a 14 in diameter cast aluminium base provided with a set of four conical frustra. The object to be photographed may be supported at a convenient height by the use of a suitable number of these cones.

The cone assembly is carried on a central vertical tube by a pair of robust ball thrust races. This tube keys into a bush fixed on the centre line of the photographic bench and is locked in place by means of the ring nut. As the turntable weighs 50 lb it has been provided with a pair of lifting handles to assist manoeuvring it into position on the bench.

The turntable is driven at one revolution per 192 sec by means of a 115V 50 c/s two-phase synchronous motor and appropriate gearing. Motor and gears are both housed in the base of the turntable. The direction of rotation of the table may be reversed by reversing the current in one of the windings of the motor.

Thus, all that is necessary to ensure a properly presented photograph is to uncap the camera lens at the instant the reference line on the cone assembly passes the index and to cap it again when this occurs for the second time.

Traversing Camera Back

The camera normally used on the photographic bench is a "Peco" Supra II 4 in by 5 in plate camera, made by Plaubel, Frankfurt a.M. It was already provided with a full set of calibrated adjustments (for height, tilt, etc.), so it was convenient to use it for periphery photography too. It was therefore decided to make a special back which would clip on to this camera when required and traverse a standard 4 in by 5 in double film holder behind a slit.

The traversing camera back was designed to satisfy three major requirements, namely: (*a*) It had to move the film very uniformly along a straight track. (*b*) It had to be light-tight despite its moving parts. (*c*) It had to incorporate an adjustable slit which could be removed for focusing.

It will be seen from Fig. 5, that fastened to a steel mounting plate (1) similar to that of a standard spring loaded back is a thick aluminium plate (2) which is the main mounting plate for the whole unit. At the top and bottom are two horizontal rods, the lower rod (3) supports a moving carriage on three geometrically mounted ball races (4) at each side of the carriage while a single ball race (5) against the upper rod locates the top of the carriage.

Secured to the main plate is a perfectly flat steel plate (6) with an unbroken surface which has a matt black finish. The aluminium frame or carriage (7) passes over this steel plate supported on blocks (8) which carry the geometric mounts, but, as it in turn carries the film, the carriage must also be light tight. Therefore, fastened to the carriage, and at each side, is a light trap (9) of thin sheet metal which encloses an inner vertical rubber covered roller (10) mounted in ball races top and bottom, while the ball race housings are secured in an upper (11) and lower horizontal light trap, with the two light traps held in position by means of two tension springs (12). The ball race housings (13) are spring loaded(14) thereby ensuring that the rubber rollers press firmly against the steel plate.

Attached to the moving carriage is a conventional spring loaded back (15) to hold a standard double dark slide film holder, with the addition of a focusing screen (16) which may be slid to one side to enable the slit (17) to be cleaned.

For traversing the carriage, a 115 volt 50 c/s synchronous motor similar to that used in the turntable is geared through a 3 to 1 ratio to a lead screw (18). The hardened and thread ground stainless steel lead screw is mounted in two bearings adjacent to the motor. To obviate any run-out of the lead screw, causing uneven movement of the carriage that may occur through bearing faces not being square with the axis, the lead screw is spring loaded, so that a hardened steel ball fitted in the end of the lead screw is pressed against a hardened steel plate on the motor face. A light alloy tube (19) fastened to the moving carriage partly protects the lead screw.

If the turntable takes exactly 192 seconds to rotate 360°, then it follows that the film holder must take that length of time to traverse plus a little excess starting time and over-run time. The actual time for the camera to traverse from starting position to "motor off" position is 201 seconds and it was felt that, after photographing an object, to return the carriage under motor power to its starting position was far too long. Therefore, a split phosphor bronze nut (20), with

each half spring loaded (21) on to the lead screw, is attached to the traversing carriage. Seen from the back of the camera, the carriage moves from right to left under power, and, by pressing the two tongues of the split nut together, thereby releasing the nut on the lead screw, the carriage may be returned manually from left to right. The cartrage, when under power traversing from right to left, is automatically stopped after its full travel, by means of a spring-loaded plunger (22) operating a micro-switch (23) in the motor supply.

The adjustable slit mechanism consists of two hardened and ground stress-relieved steel knife-edges 3¼ in long, disposed centrally about the lens axis. One knife-edge (24) is supported top and bottom by a rotating vertical rod (25) while the other knife-edge (26) is geometrically mounted and attached by springs to the first. This ensures that by adjusting screws (27) the movable knife-edge may be very accurately lined up with the other. On the top and bottom of this pair of knife-edges is fitted a thin sheet metal light trap (28).

The adjustable knife edge may be pivoted about the centre-line of its ball mounting (29), and, by means of a knurled adjusting screw (30) pressing against a stud on a bracket (31) fastened to the adjustable knife-edge, the slit width may be adjusted from 0·003 in to 0·040 in, while a calibrated disc (32) indicates the slit width. The inside faces of the knife-edges are serrated (33) to eliminate reflections which would otherwise fog the film.

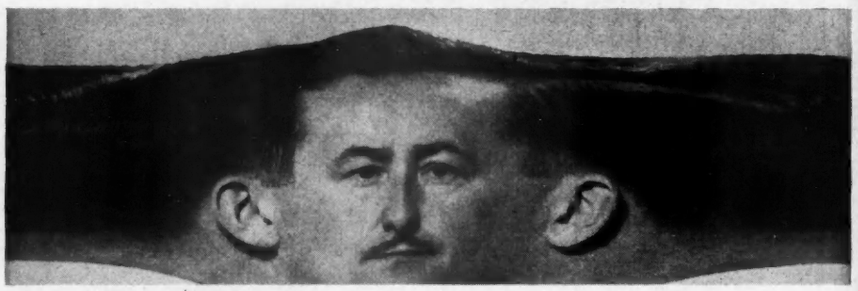
The torsion spring (34) on the vertical rod ensures that the complete slit mechanism is spring loaded against an adjustable stop (35) enabling the knife-edges to be approximately 0·010 in from the surface of the film. This vertical rod also enables the slit mechanism to be rotated through 90°, where it is automatically

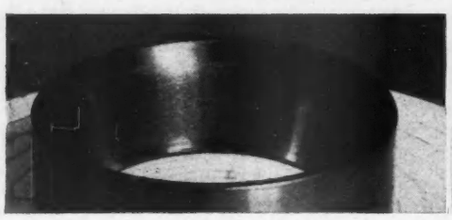
Fig. 6 (above) Periphery photograph of a badly damaged car tyre.

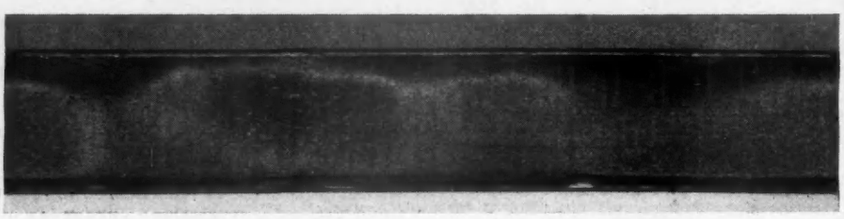
Fig. 7 (right) Periphery photograph of the deposit on a valve stem shown about three times full size.

Fig. 8 (below) Periphery portrait of Mr. F. Fox of the Photographic Department, "Shell" Research Limited.

Fig. 9 (bottom) Conventional and periphery photographs of interior of a pinion head bearing outer race.







locked in position, well clear of the lens axis to facilitate focusing, and to allow the standard film holder to be inserted into the spring back. The complete mechanism may be released by pressing the small button (36) in the centre of the releasing lever (37).

Control Box

This unit may be seen in Fig. 1 sitting on and projecting down between the large horizontal steel rods which locate the camera. It carries the transformer supplying the 115 V synchronous motors that drive the turntable and the traversing back, the on/off switch that controls these motors, and the reversing switch for the turntable motor. A buzzer, which sounds just before it is time to cap the lens, is housed in this box.

Operation

The object to be photographed is placed on that cone of the turntable which brings it to a convenient height and then it is carefully centred. The location of the object is completed by setting the turntable to a mark approximately 6° of rotation (actually 3 sec running time) ahead of the index carried by its base. The lighting is then arranged to suit the convention that has been adopted for the particular object being photographed.

The camera is next set in its proper position as determined from the appropriate calibration graph. This ensures that the moving image of the rotating object keeps pace with the movement of the film. The traversing back is then clipped on to the camera and it is focused with the slit assembly swung clear and the focusing screen in position. This is then slid aside and the slit swung back to its working position.

The film holder is then loaded into the spring back of the traversing unit and the carriage is set as far as it will go in the direction away from its motor. The exposure of the film is proportional to the slit width, being approximately one second for a 0·020 in slit. The lens aperature is set to suit the slit width in use and the speed of the film. The lighting convention ensures that the aperture determined in this way will always give sufficient depth of focus.

The lens is capped, and the direction of rotation of the turntable is selected to suit the nature of the object (internal or external cylindrical surface)

The dark slide is then withdrawn and the motors are started. At the instant the reference line on the turntable passes the index the lens is uncapped. Half a minute before the exposure is completed the buzzer warns the operator, who caps the lens at the moment the reference line again passes the index. The traverse motor switches itself off automatically. The operator switches off the turntable motor and replaces the dark slide over the film.

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[2] Luck, H. R., Rogers, T. A., and Cattaneo, A. G., "New Methods for the Evaluation and Recording of Piston Skirt Deposits." Society of Automotive Engineers *Journal*, vol. 51, No. 2 (February, 1943), pp. 38-44.

[3] Luck, H. R., "Photographing Cylindrical Objects." *Journal* of the Photographic Society of America, vol. 12, No. 2 (February, 1946), pp. 61-68.

[4] D'Isoz, Emil, Photographs by an unrevealed technique. *Illustrated London News*, Aug. 1947.

[5] British Iron and Steel Research Association, *1961 Physical Society Exhibition Handbook*, p. 113.

Plain Words

By Capricorn

I WAS delighted to read the newspaper report that Mr. Phineas Whitehouse had " unlawfully mounted a locomotive and caused it to travel from Stafford Road engine sheds, Wolverhampton, endangering people on the railway; and obstructed a diesel engine at Stourbridge "; and that he had done these things " in a fit of pique " after his girl friend had refused to marry him.

It is surprising how appropriate a tool or machine of some kind can be for giving vent to your feelings. The extra-culinary function of a rolling pin seems to be internationally recognized: a lady in Italy has recently won a competition for the Ideal Mother-in-Law, and her prize was a gold rolling pin. On a larger and more dangerous scale, there are some motorists, I suspect, who are addicted to assuaging their anger by driving their machines fast and furiously.

It is deplorable but natural. If you feel deflated; if you are powerless to prevent everything going against you; if you are banging your head against a brick wall—then a motor-car, or a rolling pin, or a steam locomotive gives you a new sense of power. It makes you bigger and more important than you really are. Your self-respect is restored, although you choose the equipment rather wildly, grabbing what is nearest.

Mr. Whitehouse, however, has a very nice sense of the appropriate. He is a former fireman on British Railways, and in the course of his 25 mile lone ride he held up that diesel locomotive " while he took on water." If, as I suspect, he had become a fireman because from boyhood upwards he had wanted to be a steam locomotive driver, only to find on joining British Railways that dieselization and electrification would thwart his ambition, then he must have taken an understandable pleasure in making one of these new-fangled diesels wait for his splendid old locomotive engine.

To have done this dreadful deed at Stourbridge was exquisitely appropriate, because it was the Stourbridge works of Foster, Rastrick and Company which in 1828 built the first " real steam locomotive ever seen in America." This famous engine was in fact named the " Stourbridge Lion " and it arrived on the other side of the Atlantic in 1829.

When Mr. Whitehouse turned the water-cock and made that diesel wait, I hope he knew what a gallant act of retribution he was performing in memory of the " Stourbridge Lion." The steam locomotive was an English export to America, the raw material of the Casey Jones legend, and a powerful factor in the pioneering of that pioneering country. What did we receive in return a century later? Dieselization ! Is it fair—is it reasonable? Mr. Whitehouse didn't think so. For letting off steam—a steam locomotive every time. And if it brings you before a magistrate next day—well, you get a kind of hangover after all the best parties.

Letters to the Editor

Not Through Textbooks

SIR, Capricorn, in his Plain Words today (ENGNG., 21 July '61, p. 69), has touched a very tender spot, in respect of " those elements of a profession that cannot be transmitted through textbooks."

Engineering is not a science—or even an applied science. It is an art, to which many sciences make their contributions. An art in which the eye, hand and brain must work in unison. The work of each reacts on, and helps in the development of, the other two.

A science may be studied in universities, or from books; but it seems impossible to transmit an art from one generation to another without some personal contact on the lines of the old master-apprentice relationship.

The great creative men of the 18th and middle 19th centuries—those who left the strongest mark on the pattern of our civilization—were the product of this older system.

Few, if any, of the exhibits at—or even the unique building of—the Great Exhibition of 1851 owed anything at all to university thought, tradition or background. They were the product of this older apprenticeship system, which was already in decline at the time.

It has now disappeared entirely, and *nothing* has as yet replaced it. This is probably a major cause of our economic difficulties. Most other nations have replaced it with something better than we have.

Yours faithfully,

HUGH CLAUSEN.

London NW2.
21 July, 1961.

Old Moore

SIR, You quote me (on page 47 of the 14 July issue of ENGINEERING) as having said at the Automation Conference at Harrogate that " Old Moore plus a computer is still better than Old Moore."

I actually said " Old Moore plus a computer is still no better than Old Moore."

Yours truly,

WALTER PUCKEY.

London W1.
24 July, 1961.

Zed Crank Engines

SIR, In a recent issue, which has just reached me, a letter from Mr. Ernest Owen Davies (ENGNG., 9 June '61, p. 789) showed an interesting design for a Zed crank engine.

As drawn, however, this would not make one revolution, as the linkage constrains all arms of the swash plate to move in axial planes. This, as pointed out by, I think, Judge, was the cause of failure of many earlier Zed crank engines. He showed that, for similarity in the movement of all cylinders, a point on each swash arm should move on a lemniscate (a figure of eight on a surface of a sphere).

I was enthused by this realization to produce several designs for Zed crank engines, and I hope some of your more enthusiastic model-making readers may be saved from disappointment.

Yours very truly,

D. G. WILSON,
Technical Director.

Northern Research and Engineering Corporation,
Cambridge 42,
Massachusetts, USA.
17 July, 1961.

Events in Advance

Practical Course on Noise Measurement

WITH a view to meeting the needs of persons already engaged in the study of noise measurement but requiring further tuition, and also to cater for those about to be confronted with problems of assessing and reducing noise, arrangements are being made by the Royal College of Advanced Technology, Salford, to hold a five-day course of study on this subject, commencing on 11 September next.

Emphasis at the course will be placed on practical measurement and efforts will be made to familiarize the students with typical noise-measuring instruments. The supporting lectures will involve only a minimum of physics and mathematics, such as will enable the persons attending to follow the instruction. Expert tuition will be available.

Applications to attend the course and requests for further information should be sent to Mr. Peter Lord, Royal College of Advanced Technology, Salford 5, Lancashire.

Selecting the Right Plastics

AN INTERNATIONAL congress on " Problems of Choice in Plastics " is to be held in Amsterdam from 15 to 17 October, 1962, and will be followed by the third international " macroPlastic " plastics exhibition, which is scheduled to take place in Utrecht from 18 to 25 October, 1962.

The papers to be presented at the congress will lay special emphasis on the considerations which should determine the choice of suitable plastics. It is the intention to divide the congress into sections corresponding to the various stages to be passed through in the manufacturing of top-grade plastics. To secure adequate products, there must be a suitable choice of basic materials, processing techniques, tools and machines, and the degree of automation required. All these aspects will be dealt with at the congress.

Modern methods of manufacture have simplified the development of new products but it is essential that these creations should be economically justified, providing plastics of high quality at reasonable prices.

The organizers of both congress and exhibition are N.V.'t Raedthuys, 5 Tesselschadestraat, Amsterdam W, Holland.

Exhibitions and Conferences

Arranged in chronological order

Scottish Motor Show, 43rd.—Fri., 10 Nov., to Sat., 18 Nov., at Kelvin Hall, Glasgow. Organized by the Scottish Motor Trades Association Ltd., 3 Palmerston Place, Edinburgh 12. Tel. Edinburgh-Caledonian 3643.

Maintenance Conference and Exhibition, National.—Mon., 13 Nov., to Thurs., 16 Nov., at the Central Hall, Westminster, London SW1. Organized by *Plant and Factory Maintenance*, Mercury House, 109-119 Waterloo Road, London SE1. Tel. WATerloo 3388.

Medical Exhibition, 44th.—Mon., 13 Nov., to Fri., 17 Nov., at the Royal Horticultural Society's New Hall, Greycoat Street, London SW1. Apply to the Exhibition Organizer, British and Colonial Druggist Ltd., 194-200 Bishopsgate, London EC2. Tel. AVEnue 1444.

Engineering Materials and Design Exhibition, Second.—Mon., 13 Nov., to Sat., 18 Nov., at Earls Court, London SW5. Organized by Industrial and Trade Exhibitions Ltd., Drury House, Russell Street, London WC2. Tel. TEMple Bar 3422.

Factory Equipment, Heating, Ventilation and Thermal Insulation Exhibition.—Mon., 13 Nov., to Sat., 18 Nov., at Earls Court, London SW5. Organized by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London WC2. Tel. TEMple Bar 3422.

A Better Way to Reward Workers' Efforts

Incentive payments have long been a means of increasing industrial productivity. The target piece bonus system claims definite advantages over rates fixed on piecework principles.

By Eardley Beswick

STRAIGHT piecework, or payment per piece operated upon, tends too much to be regarded as the fundamental form of wage incentive and is certainly the system most widely employed. There are, however, defects in the practical application of this and other systems of reward now used, but there exist neglected forms of incentive, equally fundamental, which may be combined advantageously to avoid these defects.

In theory, straight piecework represents the marketing of skill and application as between willing seller and willing buyer. On the surface, nothing could be simpler or fairer. Certainly nothing is more commonly assumed to encourage maximum effort. But below the surface, there lies the fact that fixing piece rates involves a clash of interests, as does any bargain, and that, because of this, straight piecework fails in practice to secure anything like maximum effort; a failure normally unperceived even when, as all too often, its effect is deterrent.

SCOPE FOR INCENTIVE

Being the basis of a bargain, the piecework price has to be determined by a kind of substitute haggling known as rate fixing. Only where speeds and feeds alone rule the issue need there be no kind of haggling but then, of course, there is, strictly speaking, no scope for incentive.

This scope begins only where manual dexterity or physical effort is involved and, here, some measure of time study becomes essential; the usual resort being to study, more or less in detail, the efforts of selected operators. Time study for rate fixing, however, demands a degree of cooperation from the operator such as cannot fairly be expected from one of the parties to a bargain.

Rate fixers will be aware of the dodges and allowances that can be resorted to to avoid this basic difficulty, but one needs neither their experience nor their special techniques to realize that, even with the most cooperative of workpeople, no amount of detailed study will secure results correct for varying aptitudes and no formula can take account of the steady acceleration of hand movements repeated over years, which will take place quite naturally if not inhibited.

The most the rate fixer can do is to determine the norm of dexterity at a given period, an inevitably too early period, and even if he succeeds in doing this the less efficient employees will be discouraged by their inability to achieve this norm, while the exceptionally dexterous will be in a position to run away with the job or, what is infinitely worse, to hold back on it.

In practice, the inherent deficiencies of time study result in a preponderance of fat and lean prices. Too often, they will result in catastrophic prices, by which is meant those so much too high that they would, if taken full advantage of, provide earnings far in excess of what wage-negotiating bodies would regard as reasonable. It is because such prices are rarely taken full advantage of that they seldom become evident for what they are.

Reluctance to take full advantage of the fat price may often have resulted from the vicious practice of cutting such prices but this practice is less common than it was once and the best employers have always stood by their piecework bargains. Even with the best employers, however, the too-generous price has, when recognized, served as a legitimate incentive to improve methods. Many valuable advances in technique, and a perhaps greater number for which the term improvement would be no more than a courtesy title, have been started in this way.

As a result, operators have learnt that high earnings encourage changes of method and the disappearance of still other fat prices, so that, today, we may safely expect the sophistication of the worker to be such that over-high earnings will be consciously avoided; that is, the shop on a piecework system will produce fewer operations than it should and these at a higher than economic price.

Restriction of output, moreover, will not be confined to over-priced jobs. Work under priced will be under produced, to the end that low output may enforce an upward price revision. In effect, in the piecework shop, there will always be a background conspiracy to restrain effort; the very opposite of the result anticipated in theory.

Another important defect of straight piecework, commonly ignored, is that the piece rate will probably determine the level of output for a long time ahead, often for years; whereas a progressive increase in dexterity invariably results from long practice. As a rule, the rate is fixed after, at most, a few weeks' investigation and the rate fixer, under the urge to get the job on piecework, must ignore the possibility of progressive improvement. He fixes a price and the efficiency of the job is thereupon frozen.

EFFICIENCY FLUCTUATIONS

Those who have at any time taken the trouble to measure day-to-day shop efficiency will commonly have observed a deterioration of effort as the week progresses. The easy explanation for this is "fatigue." More often than not it should be attributed to the deficiency of the reward system, in so far as the system in force fails to provide a stimulus effective throughout the week or, for that matter, a boost at the point where slackening is observable.

The logical cause of this almost universal deceleration is usually that, by dint of earlier concentration, what may be regarded as politic earnings are in sight and the operators, intelligently, decide to take things more easily. A simple confirmation of this diagnosis may be deduced from the increased effort normally observable before a holiday when, extra money being desired, some of the slack will temporarily be taken up. Indeed, many shops will have accommodated recent reductions in hours without any corresponding fall in output; a matter for congratulation perhaps but the slack was there to be taken up.

This brief analysis of straight piecework should serve to justify the assertion that the deficiencies of rate fixing based on time study conduce to the limitation of output. These shortcomings have been emphasized because they act like a debilitating disease in light industry. In most cases, so long as the operator earns at least time and a third and does not too often, or too blatantly, exceed time and a half, the rate fixer, the shop steward and, of course, the operator, are likely to congratulate themselves on having reached a satisfactory compromise. It is doubtful if, in the interests of the efficient use and future security of his capital, the employer can afford to share their complacency.

That the risks of catastrophic earnings have not been exaggerated is evidenced by the existence of incentive systems whose primary object, more or less concealed, is to taper off the rate of reward and so render such earnings unattainable. However skilfully this object may be hidden in the make-up of the bonus it will be commonly suspected by the operators and resented.

A variety of such systems, admittedly, have met with much success on medium and heavy-engineering work where speeds and feeds are the main consideration and where, though there may be only exiguous room for increasing output, some semblance of incentive must be assumed in order to justify a level of earnings at which the required labour force can be recruited and maintained. On manual operations and on light repetition work generally, reward systems which taper off at higher levels of production have proved less suitable, their failure resulting from inherent defects to meet particular needs. These defects may be summarized thus:

1. The possibility of accurate rate fixing diminishes in proportion as the manipulative element of the job increases and the resulting fat and lean prices react against effort as already described.
2. Where reward is paid on a diminishing scale, on a proportion of the time saved, the operator's comprehension of the system's make-up becomes increasingly difficult as the time cycle decreases from hours to split seconds.
3. Operators resent receiving less for efforts made under what they may regard as conditions of increasing fatigue.

Any improved system for rewarding work requiring dexterity of muscular effort must therefore:

1. Be largely independent of time study.
2. Avoid the risk of catastrophic earnings.
3. Not tend to freeze the level of output
4. Take more fully into account the worker's normal reactions to incentive stimuli.
5. Either apply an effective stimulus throughout the week or be capable of easy boosting at the point where effort is observed to flag.
6. Produce results that are easily understood and checked by the operator.

All these requirements can be met with a considerable cost advantage by the combination of two simple incentives, each as strictly fundamental as the piecework price.

Whoever first offered workers a bonus per piece produced, in addition to their daywork wage, had the right idea. If it had only occurred to him to make this bonus conditional upon the achievement of a target output, he would have been in sight of a much better system altogether.

TARGET PIECE BONUS

What may conveniently be named the Target Piece Bonus system is, therefore, as its name implies, no more than a combination of two elementary incentives: a *target* output whose attainment, as a minimum to be averaged throughout the week, is rewarded by a *bonus*, additional to the day rate, and paid for per piece or convenient number of pieces.

There are thus two things to be predetermined, the target quantity and the bonus rate, neither of which demands time study. Bonus rate is a fraction (usually one-fifth, one-fourth or one-third) of the hourly rate applicable. This sum is paid extra for the target quantity and expressed in terms of pence per piece, per hundred pieces or per thousand. The fixing of the target demands no more than a humane approximation of what is attainable by the average operator. Target errors do not affect ultimate earnings. Bonuses on the scales suggested cannot result in catastrophic earnings.

Targets can usually be determined by reference to output records for similar jobs. Where there is no experience to act as a guide, time study may be helpful and its limitations will present no risks. On the whole, no specific technique is demanded of the target fixer and the necessary aptitude can be acquired in a short preliminary training. Although high targets may tend to inhibit effort, in so far as they may be regarded as unattainable, and low ones to make reward too

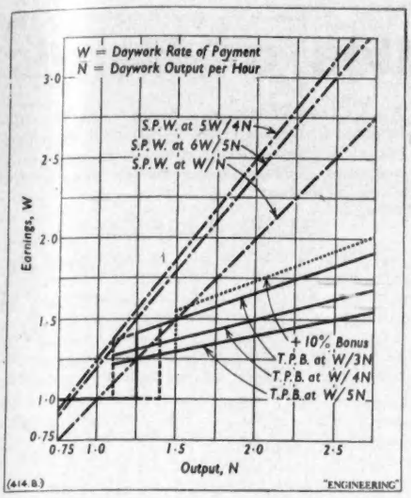


Fig. 1 Individuals' earnings under the target piece bonus system compared with those under straight piecework over equivalent ranges of reward.

easy, errors as great as ± 20 per cent above the norm of possible achievement inside three months will not prove serious. Also, target errors are easily recoverable, because operators familiar with the working of the system will accept target revisions realizing that ultimate earnings are not likely to be affected.

As to the reactions of the operator under the target piece bonus system, the incentive effect of a target lies in the realization that, on attaining a specific rate of achievement, one will receive an extra payment for each piece which has, up till then, been processed for day money only. The urge underlying that realization need not be emphasized. Moreover, since the target rate has at least to be averaged, slacking risks the losing of rewards already won, whereas, under straight piecework, every piece made, however slowly, after day rate has been earned, adds something to earnings.

Under the target piece bonus system, it has been noticeable that operators who find, say on the fourth day of the week, that they have averaged slightly under the target rate, will make an all-out effort on the fifth day and will, in future, time this effort somewhat earlier. In general, the target operator soon learns that every hour must see the target beaten and it is only when the target has been set very much too low that easing off will not obviously jeopardize what has already been earned.

SYSTEMS COMPARED

In the accompanying graphs, earnings and costs, respectively, have been plotted for both systems over equivalent ranges of reward.

Fig. 1 contrasts individual earnings over the same range of outputs; daywork rates of W units of currency per hour and daywork outputs of N pieces per hour being assumed. Straight piecework earnings have been plotted for prices of W/N, 6W/5N and 5W/4N, equal to single-time, time-and-a-fifth and time-and-a-quarter minima. Against these, earnings under the bonus scheme are plotted for bonuses valued W/5N, W/4N and W/3N, rates aiming at time and a fifth, time and a quarter and time and a third, respectively. It may be noted that the target level has been set for an output of 1¼ times N pieces per hour.

What stands out immediately is the greater steepness of the straight piecework curves, which is a visual demonstration that piecework earnings rise much faster than do those for target piecework bonus, as output increases. Earnings as high as 2W, or twice day rate, may be regarded as verging on the "catastrophic," and, under straight piecework, these are reached for outputs less than half those required under the target piece bonus system.

It might be expected that the slower rise in earnings under the latter system would have a deterrent effect. In practice, this has not proved to be the case and, indeed, fat and lean prices having been eliminated, with all that ensues therefrom, nothing equivalent to piecework remains to apply brakes on production.

Fig. 1 also illustrates the effect under the target piece bonus system of high and low targets on earnings. Dotted vertical lines at 1·1 N and 1·4 N show that even a wide shift of target levels has no effect on ultimate earnings. In effect, nothing has been altered except the point at which a bonus begins to accrue. In other words, even large errors in target fixing affect results only in so far as they may influence the incentive stimulus in the ways already mentioned.

In Fig. 2, cost curves have been plotted on the basis of the earnings shown in Fig. 1. The general formula is: cost per piece = earnings per hour plus oncosts, divided by the number of pieces produced per hour. A constant oncost of 200 per cent on day wages, or 2W, has been assumed.

In considering Fig. 2, it should be remembered that, although all the curves have been drawn to the full extent of the graph, outputs under straight piecework will not normally be allowed to exceed the range of 1·5 N to 2 N, whereas outputs as high as three times the normal are being regularly maintained under the progressive encouragement of the target piece bonus.

BOOSTER BONUSES

Reverting to Fig. 1, mention may be made of the increment shown by a dotted line at a level of 10 per cent above the line for the W/3N bonus. This dotted line represents the effect of offering an additional 10 per cent bonus on the attainment of an output of 1¼ times the normal.

This same dotted line represents, roughly, a 45 per cent extra bonus on the W/4N level and an 80 per cent extra bonus on the W/5N level. It is regretted that the full treatment of booster or plus bonuses cannot be dealt with here owing to space limitations.

Some applications of the system may be mentioned. The target piece bonus system was applied in 1946 at a pilot shop employing about 100 female operators engaged on hand operations and more or less delicate assemblies of small electrical components. This shop had, up till then, relied for incentive on team spirit, on competition with similar units, and on war-effort enthusiasm.

Targets were set at around 50 per cent above previous daywork averages for the existing range of some 180 different operations. These targets represented about 25 per cent above the recorded peak efforts. A bonus was offered of W/4, or 3*d* in the 1*s*, on the day wage. Targets were lowered for beginners, with progressive increases during the learning period until such time as the full bonus was attained.

Within a very few weeks, the majority of operators were earning the bonus and, within a few months, the shop was averaging 50 per cent above its previous peak figures. Those who have applied other forms of wage incentive to a previously daywork shop will not be over surprised by such results, good as they are.

It is, however, by what has followed over the ensuing 14 years, during which the level of output has continued to rise, that the true effectiveness of the system can best be judged, for, right up to the present time, bonus earnings per operator-hour have shown a steady increase. This has been so in spite of the fact that the first and second national wage awards and recent reductions of working hours have been absorbed without raising either bonus rates or targets. In effect, wage increases to date have more than halved the original bonus rate of 3*d* in the shilling.

After the second national wage award, a tendency to rest content with earnings of around time and a half became obvious. The indications were that wage increases had been allowed to dilute the bonus rate too far and that the original targets had been set too low. A group bonus, with an overall target set for the shop as a whole, was then applied with the effect of permanently raising the level of achievement. It was later superceded by a graduated booster bonus which continues to operate. In the result, peak outputs around double the target level have become commonplaces. Since targets were set at 1·5 N such output represent three times the original daywork effort. Under straight piecework they would, if attained, have cost 50 per cent more than they do under target piece bonus.

Since the introduction of the system, employees in this pilot plant have more than doubled; time for training beginners to attain target outputs has fallen from an average of 12 to one of three weeks; three national wage awards have been absorbed without increasing bonus rates or altering targets; a recent reduction of hours has failed to check the steady rise of production.

The next application of the system was made in a press shop handling light to medium work. Here, various types of incentive, including straight piecework and premium bonuses, had failed to secure the results that, in the experience of the management, should have been attained. In view of this experience it was decided to fix targets at only 10 per cent above previous peaks.

According to the firm's management, production was raised inside six months to some 20 per cent above previous peaks and has continued to rise ever since. After its application to the main press shops, it was desired to extend the system to a small plating shop. Here, weights handled having proved the only reasonably constant factor in a survey of the shop's widely varying flow of work, a target was set at 20 per cent above the previous record week's tonnage. A bonus per ton was offered, to be shared in proportion to daywork earnings. As a result of the introduction of target piece bonus, outputs originally requiring a gang of five or six men are now exceeded by a gang of three working a shorter week.

CONCLUSION

It only remains to point out that in none of the above cases did the system involve an addition to clerical staff. In the original pilot shop, the addition of one girl clerk sufficed to cope with a doubling of the labour force. In fact, a total staff of three girl clerks suffices to provide wage figures and to produce detailed production and cost summaries each month.

The writer is indebted to Mr. Charles McNeil, M.A., B.Sc., and Mr. P. A. Cosh for their inspiration.

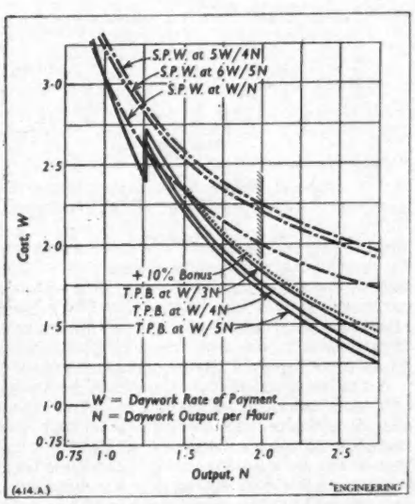


Fig. 2 Firms' costs under the target piece bonus system compared with those under straight piecework over equivalent ranges of reward.

Computing How a Car Handles on Bends

Car stability can be computed when the way cornering force varies with tyre slip is known. Studies on a 1960 Ford show how the degree of under-steer can be varied and how this alters stability.

MOTORISTS are growing more critical of the handling properties of their cars. Good performance on bends is becoming more important as driving speeds increase. Accurate descriptions of a car's performance in this respect, however, are rare. Two drivers reporting on the same car have been known to contradict each other completely as regards its steering qualities, and manufacturers rarely offer any information about the steering qualities of their cars.

This situation has arisen because of the difficulty in analysing car stability mathematically. Designs have largely been produced as a result of cut and try methods. Now higher speeds, new suspension systems, lower cars, and more powerful engines have made the problem of stability more complicated. An analytical method is sought instead of an experimental method due to the speed of solution.

The path being followed by the Ford Motor Company, Dearborn, Michigan, to develop such a procedure is described in a paper "An Improved Analog for Vehicle Stability Analysis," by F. N. Beauvais, C. Garelis, and D. H. Iacovoni. It was read at the 1961 SAE International Congress. Solutions of the mathematics deve-

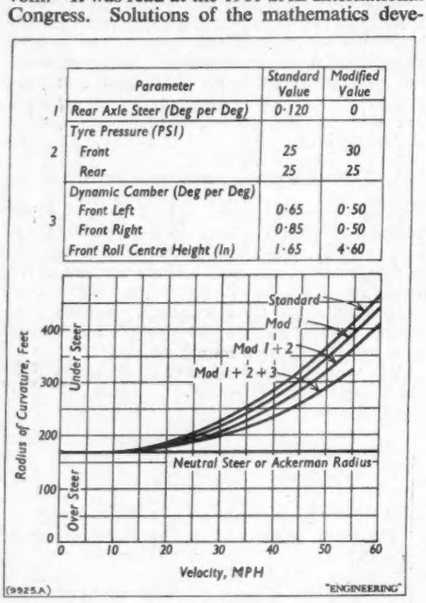


Fig. 1 Various simple modifications alter the steady-state steering response of the 1960 Ford.

loped so far require the use of a digital computer. At present the steady-state solution of vehicle stability is being evaluated on an IBM 650 and the transient solution on an IBM 704. Ford hope that their work will lead to innovations to provide a vehicle with handling qualities not possible with present design configurations.

A mathematical model of a car is produced, based on techniques developed in the study of aircraft stability and control. Previously this has been carried out for lateral accelerations less than 0·30 *g* by assuming that tyre cornering force is a linear function of slip angle. The Ford work uses a non-linear function that allows the study of vehicle motion to the point of impending skid. Cornering force is defined as a function of slip angle, camber angle, and vertical load.

Three degrees of freedom are considered—roll, yaw, and sideslip—with forward velocity assumed constant.

Because of limited experimental and theoretical knowledge on the effects of traction and braking on cornering force, these effects are not represented in the analysis. The relation between cornering force, slip angle, camber angle, and vertical load have been relatively well established experimentally and a theoretical investigation conducted by Fiala has established a mathematical relation based on the deformation of the tyre tread in the contact patch.

A comparison between the variation of computed and measured cornering forces with slip angle showed good agreement. Also the effect of camber could be seen to decrease with increased slip angle, indicating that the effects of camber become less significant under severe cornering conditions.

It was then necessary to develop expressions relating slip angle, camber angle, and vertical load to the motion variables of the vehicle. For the slip angles, a relation for each front wheel is necessary, since the front wheel steer angles may have different magnitudes. The rear wheel slip angles are assumed equal between right and left wheels and the rear axle roll-steer effect is also considered. The camber angle of each wheel is a function of the vehicle roll angle, which may be a linear or non-linear relation, depending on the suspension geometry. For the vehicles studied, a linear representation has been adequate.

The vertical load of each wheel is assumed to consist of a static load component plus a dynamic load component. The dynamic load component results from the lateral inertia weight transfer plus the aerodynamic effects.

OVER AND UNDER-STEER

An under-steered vehicle travelling in a given curve at a given front wheel steer angle will assume a larger radius of curvature as the vehicle velocity is increased, whereas an oversteered vehicle will assume a smaller radius of curvature. The neutral-steer vehicle assumes a constant radius of curvature regardless of the velocity. These definitions are for steady-state conditions only and cannot be applied to the transient condition, even though during the transient the vehicle may, because of its oscillation, appear to be under-steering at one instant and over-steering at another. The terms "over-steer" and "under-steer" used in this manner have no precise physical meaning but describe tendencies only.

A 1960 Ford was used as the basic vehicle for the computer analysis. In the initial study, which was limited to cornering, aerodynamic effects were neglected, and the lateral load transfer was a result of the inertia forces and moments only. The distribution of this lateral load transfer between front and rear is a function of the front and rear roll centre heights, the weight distribution, the front and rear wheel treads, and the front and rear roll rates.

As far as the roll rates are concerned, where the front roll rate is much higher than the rear roll rate, the vehicle is highly under-steered throughout the velocity range. When the rear roll rate is greater than the front, the vehicle changes from an under-steered condition at the lower velocities to an over-steered condition at the higher velocities, resulting in eventual rear-end spin out. Increasing the total roll rate decreases the degree of under-steer.

The addition of a roll bar to the front of the 1960 Ford reduces the under-steer at the lower velocities, but it induces a greater degree of under-steer at the higher velocities or the more severe cornering conditions.

Several parameter changes were made on the 1960 Ford to reduce under-steer. These are presented in Fig. 1. With each of these changes, the vehicle showed a steady-state response trend approaching the neutral-steer condition. The changes that were made are quite feasible and demonstrate the utility of this approach to vehicle design. However, the transient response in each case must also be evaluated to determine overall vehicle behaviour.

TRANSIENT RESPONSE

In the transient analysis, the front wheel steer input is a ramp of 3·5° magnitude occurring in 0·25 sec. Such an input can be achieved by a driver—as has been demonstrated in tests.

Fig. 2 shows the effects of forward velocity on the yawing velocity transient response of the 1960 Ford. The 40 and 60 mph curves exhibit

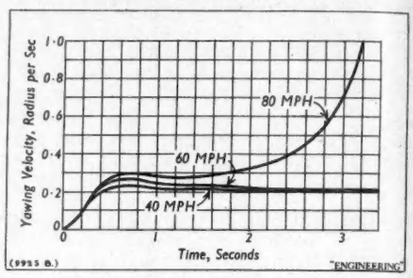


Fig. 2 The transient steering response to a ramp input varies with speed.

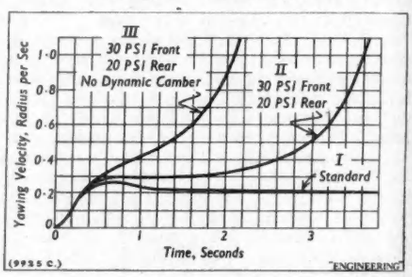


Fig. 3 Reducing the amount of under-steer reduces the time to reach a skid.

very little overshoot and quickly settle out to some steady-state condition. The 80 mph curve, in contrast, does not reach a steady-state condition, but exhibits rear-end spin out. This requires an appreciable time interval, however, during which a corrective steering manoeuvre would normally be made. The addition of a roll bar increases the time interval between the beginning of the manoeuvre and skid.

Fig. 3 shows the effects of various degrees of understeer on the yawing velocity transient response. Curve I represents the standard vehicle, and Curve II shows the same vehicle with 30 lb per sq. in front and 20 lb per sq. in rear tyre pressure. The least under-steered condition represented by curve III was obtained by reducing the dynamic camber of each front wheel to zero, as well as maintaining 30 lb per sq. in front and 20 lb per sq. in rear tyre pressures. Clearly a reduction in under-steer reduces the time to reach skid after initiating the manoeuvre.

By plotting the path of a typical under-steer vehicle, it has been shown that the centre of gravity traverses a smooth path, whereas the front end of the car moves relative to the vehicle path. This characteristic was determined from computer studies and, for the purpose of illustration, the lateral deviation of the vehicle front end relative to the path of the centre of gravity is exaggerated. The magnitude of this motion has been found to approach three-quarters of a foot, and is a function of the time-rate-of-change of the vehicle side-slip angle. Any excessive overshoot or oscillation of the side-slip-angle response will thus give the driver an uncertain sense of directional control and result in excessive corrective movements.

Human Element

Housing Minister Supports NHB House Certificate

Mr. Henry Brooke, Minister of Housing and Local Government, has advised new house buyers to find out whether the house they are thinking of has gained the certificate of the National House-Builders Registration Council. The occasion of Mr. Brooke's commendation was the presentation of the 150,000th certificate awarded by the Council.

Their certificate is a warranty that the specification for the house indicates soundness of construction. It is also a warranty that the specification has been followed and that the work put into the house at each stage has been up to standard.

Part of the process leading up to the granting of the certificate is the inspection of the house as building proceeds. Those builders who take part in the scheme undertake to make good at their own expense defects which show up within two years and which arise from a failure to comply with the required standards.

Speaking at Leverstock Green, Hertfordshire, Mr. Brooke said that there were good houses being built which did not carry the certificate—but how was the purchaser to know that they were good?

" My advice as Minister of Housing to anyone not employing his own architect but thinking of buying a new house is to ask whether it carries the Council's certificate, and to refuse to be put off. The certificate is his assurance of a satisfactory job—a house that will give long service without heavy expense for repairs."

Mr. Brooke looked forward to the time when all the good builders are gathered into the National House-Builders Registration Council, so exposing the black sheep whose activities harm the reputation of the building industry.

No Amalgamation for Municipals and Civils

After three years of negotiation the scheme for the amalgamation of the Institution of Municipal Engineers with the Institution of Civil Engineers has been dropped.

Although a majority of voters in the Institution of Municipal Engineers were in favour of amalgamation the proportion in favour was not high enough to reach the 66⅔ per cent which a special general meeting had decided would be necessary for the amalgamation to go ahead.

The Municipals held a special general meeting at Brighton in June to consider two resolutions relating to the conditional agreement made with the Civils on 10 October, 1960, for a scheme of amalgamation. A poll having been demanded on a resolution relating to the terms of the proposed amalgamation, voting began at Brighton and was continued at 28 district centres. The result was a 56·8 per cent vote for the proposal. For amalgamation there were 1,342 votes and against 1,020.

Since the two-thirds majority had not been reached it was decided that no further action could be taken towards the amalgamation.

Dilemmas in Regional Development

Regional development, a subject of perennial importance in the United Kingdom, is taken as the theme of the European Productivity Agency's spring-summer issue of its magazine European Productivity.

The way in which regional development in France, beginning as a method of decentralization in order to absorb the Paris overspill, has developed into a comprehensive policy governing the whole country as part of the European community, is a useful example of the importance to industry of regional planning and its development.

Edgard Pisani, who is Senator for the French Haute Marne Department, writing on this development puts the total of France's new population which will have to be found jobs and homes in the provinces by 1980 as high as 10 million. A determined attempt is being made to stop the hundred-year-old process in which the whole national growth has tended to take place in and around Paris.

Skilled Labour

For the location of industries in relatively new areas, in addition to communications and materials the prospective industrialist necessarily looks for a skilled labour force with a suitable proportion of adaptable technicians. Brittany is a typical example of an under-industrialized area, lacking in trained labour, to which those responsible for the direction of industries are reluctant to move.

Development must accordingly start with training colleges and apprenticeship centres. The young trainees may qualify and move off to areas of established industry but before long, says M. Pisani, industry will move into centres where skilled labour is being trained.

More than one method of decentralizing has been tried in France and with them come certain disadvantages. At one time the authorities tried the withholding of approval for development work in Paris factories, trusting that this would force the expanding concern to move to the provinces. Apart from some successes the more common result was that workers had to do their job under bad conditions.

Distortion

This form of coercion tends to be succeeded by the carrot, by incentives, tax reliefs, subsidies, compensation for moving out of the capital, all quite effective in their fashion but capable of producing a distorting effect on the manufacturing economy.

In M. Pisani's view regional industrialization is not successful until the regions themselves are equipped up to the point where they are attractive to industry. Instead of vetoes and incentives there is the creation of the necessary infra-structure. In this field Government activity, in other words the investment activity of the taxpayer, can be more effective, and without the danger of throwing the most effective pattern of the economy out of shape.

Since it is not thought to be possible to develop a whole area as an attractive industrial centre the favoured move is the preparation for industrial advance of the existing capitals of either large or small areas. Thus the growth of industry is canalized to a number of what are hoped to be natural growth points, and even those in limited number. Seven provincial areas each with one million people are likely to be a more effectively growing network than seventy towns each with populations of 100,000.

Reorganization at the Electricals

An important reshuffle in the organization of the Institution of Electrical Engineers has been announced from Savoy Place.

In the place of the former specialized sections, Electronics and Communications, Measurement and Control, Supply and Utilization, the Institution is to have three divisions, two representing electronics and power interests, and the third a general division. The last of the three will cover activities of common interest to all engineers, such as technological education and basic measurement.

Within each division will be a number of technical groups covering appropriate specializations. One distinct advantage of the new organizational pattern will be the flexibility with which it will be possible to reflect the swift development of electrical science and engineering. Each division will be guided by its own elected board. Institution members will be able to take part in the activities of as many technical groups as are of interest to them. They will have the right to vote in elections to the divisional board or boards responsible for the technical groups in which they have registered.

As at present, the leadership of the Institution remains with the Council, advised by standing committees. The influence of the divisional boards on policy will operate through strong representation on the Council and on the standing committees. The local centre committees will be free to operate their own specialized groups in the fashion that best suits their local conditions.

Quick Response

The reorganization follows two-and-a-half years spent in studying the facilities of the Institution, and one likely effect of the new system should be a speeding up of the organizational response in the Institution to emerging developments. The IEE, in its announcement of the changes, says that it has been difficult to demonstrate the high proportion of electronics activity carried on in the Institution, particularly to the young electronics engineer who is beginning to specialize. The true proportion may have been obscured by electronics appearing as only one specialization in four.

Intended specifically to remove these limitations, the new divisional structure and the technical groups give the Institution a first class formula for reacting swiftly to the changing electrical engineering field.

The scheme is due to come into operation from the beginning of the 1962-63 session, that is from 1 October, 1962. A special general meeting will be called to consider the necessary changes in by-laws. Full details of the new structure are to be announced later.

Growing Membership of ILO

Steady progress continues to be made by the International Labour Organisation. A report on this progress was made by Mr. David Morse, the director-general, at the opening session of the three-week meeting of the International Labour Conference, the organization's executive body, in Geneva.

Last year, no fewer than 16 States joined, all but one of them being newly-independent African countries. It is expected that the total of nations within the organization will shortly reach 100, since 97 States already belong and three others have applied for membership. It is not always realized that the International Labour Organisation is the oldest of all the bodies in which the governments of the world meet together to confer about their problems.

When the conference opened, there were nearly a thousand delegates and technical advisers present, representing the governments, employers' associations and trade unions of 87 countries: the highest attendance to be achieved so far.

Improving National Living Standards

Helping the different member-countries so to organize their resources that the inhabitants may attain higher standards of living is one of the main objects of the International Labour Organisation.

For example, the organization will assist and advise countries proposing to set up employment exchanges, preparing to initiate social security schemes, or establishing vocational training in industries that are in the early stages of development. A substantial expansion of the organization's programme of technical assistance, on these and similar projects, has taken place during the past year, in order to meet the growing volume of requests for aid from newly-independent and emerging nations.

In all, 348 experts from the organization have been engaged during the past year upon a total of 367 missions, and the report of the director-general shows that activities in connection with the training of workpeople in the less developed countries will soon be undertaken on a substantially larger scale. Particular mention may be made of the organization's efforts in assisting the preparation of young people for productive employment and in training suitable candidates as teachers and instructors, and as supervisors, technicians and engineers.

New SIMA President

The 1961/62 President of the Scientific Instrument Manufacturers' Association of Great Britain is Mr. A. W. Jones, of Fleming Radio (Developments) Limited. Mr. G. C. Ottway, of W. Ottway and Company, the retiring President, becomes a Vice-President.

Behind A. W. Jones is one of the success stories in scientific instruments. Leaving Pye in 1945, he founded Fleming Radio on £300 in the corner of a friend's workshop. The company now has a 38,000 sq. ft factory at Stevenage, designs and produces its own instruments and does the same for other companies. Later this year it is expanding by another 20,000 sq. ft.

Productivity in an East German Shipyard

The author recently visited the Warnemünde shipyard on the Baltic coast. In an exclusive interview with the production engineering staff, he learnt how they have established themselves among the world's shipbuilders within only a few years, and how they are planning for the future.

By Peter Trippe

THE Warnemünde shipyard, just outside Rostock on the Baltic coast of East Germany, now claims first position among the shipbuilders of the Soviet bloc, including those in the Soviet Union itself. Some Russian yards, its staff admit, may be larger, but they consider that none has developed a better production system.

Certainly Warnemünde has evolved a very well rationalized prefabrication system, by any standards. Their success is all the more remarkable when one appreciates the full nature of the handicaps, resulting from the political and economic division of Germany, which had to be overcome in order to develop a shipbuilding industry at all. It is necessary to understand the limiting factors imposed by this situation before a valid assessment can be made of the quality of Warnemünde as an engineering project.

The partition left East Germany with virtually no indigenous sources for engineering raw materials at all, and divorced her from her natural sources of supply, which remained in the Western sector and became inaccessible.

Thus East Germany found herself without any iron or steelmaking capacity—and so built the enormous Stalinstadt pig iron plant. This in itself is an unusual achievement inasmuch as it was the beginning of a considerable iron and steel industry without raw materials behind it, since, with the exception of some insignificant quantities near the Hartz mountains, she has no iron ore. There has been no way of overcoming this, except by producing goods for export to the Soviet Union in order to receive iron ore in return, a factor which, taken cumulatively with all the others, has strained her economy to the utmost in this initial construction period.

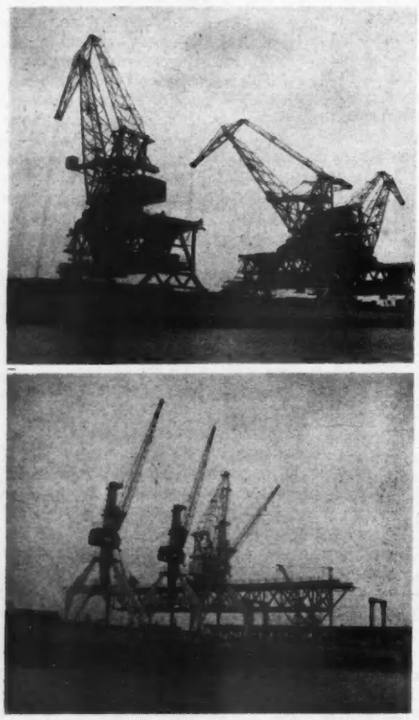


Fig. 1 Two views of the deep sea harbour at Rostock which had to be cut out of solid land.

There is neither hard coal for general use nor for processing into coke for the steel furnaces; so they had to invest something around a hundred million pounds in developing their soft coal, or lignite, seams. Having done this, they then had to devise methods of making coke from lignite briquettes. This, in turn, involved the development of special low hearth furnaces to use it.

Handicaps such as these were enough to inhibit any engineering industrial development. However, in the shipbuilding field, the situation was even worse. There was no great tradition of shipbuilding behind them. They were, and still are, acutely short of ordinary manpower and, particularly, of skilled specialists at executive level, a position which has been aggravated by an actual decrease in the working population *per capita* due to the lower birth rate during the war, and the fact that many executives left the area. Apart from the free port of Hamburg, which they distrust, they had no access to the sea. The deep sea harbour now in use at Rostock (Fig. 1) was quite literally dug out of the ground. A few years ago there was a village on what is now a 12 kilometre deep-sea channel.

FOUR 10,000 TONNERS AT A TIME

The standard ship produced at Warnemünde is a 10,000 ton tanker or general purpose vessel, known as the Type 4. The first of these ships came off the stocks during the year 1954-55. For a prefabricated ship, the productivity, as might be expected from a new and inexperienced yard, was low. We were given a figure of 148 man-hours per ton. At the time of our visit they were building the fourteenth ship of this type, and had reduced production time to 90 man-hours per ton, which compares favourably with the general level of productivity in the shipbuilding industry throughout the world. In the present seven-year plan they are committed to reducing this to 86 man-hours per ton by 1965, a target which Warnemünde's chief production engineer seemed to think would be easy. His own opinion and the general opinion in the yards themselves was that this figure could be attained without difficulty by next year, or some three years ahead of the official target.

There are always four ships on the stocks at a time, the production schedule being so arranged that they are dealt with progressively. The total time to build one of the 10,000 tonners is one year from start to finish. Of this, a total of three months is required to bring the work up to the pre-assembly stage, four months is necessary on the stocks, and five months in the fitting-out basin. Of the latter period, one month is for final trials, testing, and so on.

The Great Hall, where all the prefabrication work is carried out, is the largest in Europe, having a working area of 200 metres by 100 metres. Plates for prefabrication come from the adjacent steel yard where they are automatically descaled, put through straightening rolls, and profile-cut on automatic flame-cutting equipment. They have only been using automatic profile cutting since May of last year, when the new machines were installed. There are three machines altogether, all of the Monopole type purchased from West Germany, with ratio-working at 1 to 100 using the photographic-optical method.

The installation of these machines alone indicates the magnitude of the investment which the state is willing to put into this industry. At a rough estimate, these three Monopole machines probably cost about £160,000. It is of significance that the Warnemünde production staff give credit to these machines as being the major factor in their rapid increase to world-level productivity figures; and that, faced with the question as to whether it was necessary, in view of the industrial economic pressure on East Germany as a whole, to invest in three machines at this stage, they replied without a moment's hesitation that they could not have afforded to do anything else. This comment may perhaps be of some special interest to shipbuilders in this country who still maintain that they cannot justify the expense of even one automatic ships' plate cutting machine. And it is a sobering thought, also, to consider it in context with the fact that, apart from the very specialized BOC-Ferranti computer-controlled Eagle machine,

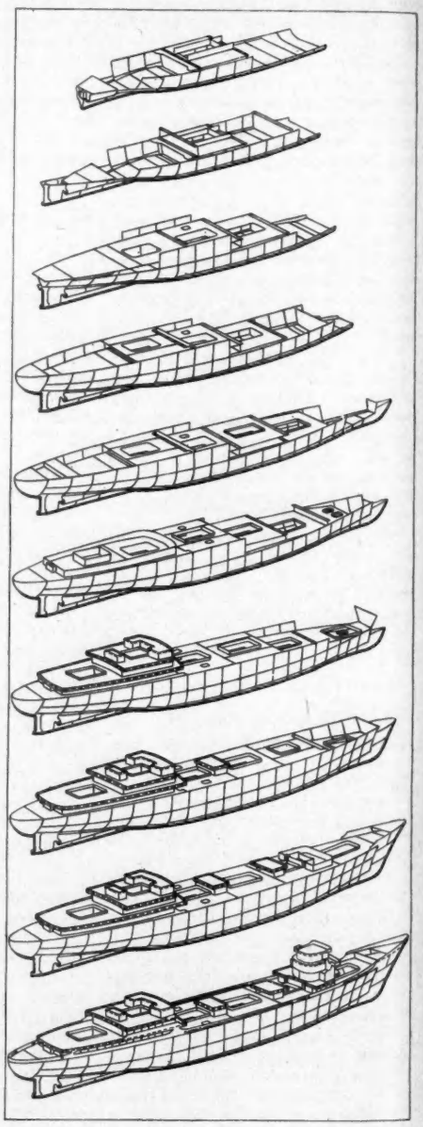


Fig. 2 Prefabrication is carried out on the "island" principle. These layouts for the 10,000 ton Type 4 tanker demonstrate the progressive addition of prefabricated sections and the method of assembly.

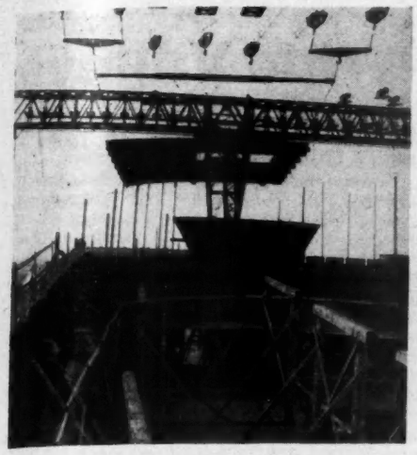


Fig. 3 A typical prefabrication section. There are about 150 prefabrications in a 10,000 ton Type 4 ship.

Fig. 4 The pre-assembly yard follows on directly from the great fabrication hall, the largest in Europe. The main stocks are beyond.

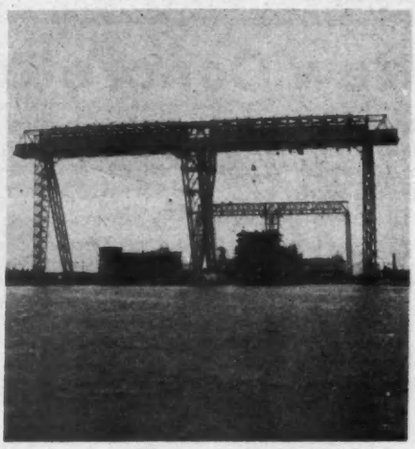


Fig. 5 The main assembly area from the seaward side. It deals in progressive stages with four ships at a time.

the first of which is now completing its commissioning trials at Swan Hunter's, Works no British flame-cutting machine manufacturer has yet seen sufficient incentive in British yards to justify designing and building an automatic ratio cutting machine for these purposes.

With the Monopole machines, of course, the Warnemünde yards have been able to dispense with lofting sheds and have been able to put the space to better purpose.

Prefabrication is carried out on what is known as the "island" system. The prefabrication hall can prefabricate sections up to 54 tons and has sufficient capacity to provide output on the basis of four ships on the stocks at any one time. Automatic submerged arc welding, using equipment built in East Germany, accounts for 59 per cent of the welding used in prefabrication. Layouts of a Type 4 10,000 ton vessel, from which the typical prefabricated sections and the method of assembly may be seen, are shown in Fig. 2.

Leading immediately out of the prefabrication hall is the pre-assembly yard, which feeds into the main stocks beyond. Both are serviced by a cable crane equipped with 24 cables, each capable of carrying 10 tons. They regard this cable crane as now out of date, preferring the flexibility of handling offered by tower crane layouts, and any future such installation will doubtless include the latter type. The cable crane has a working range of 320 metres and is 65 metres high. A 10,000 ton ship has about 150 prefabricated sections.

A typical section is shown in Fig. 3, the pre-assembly yard is illustrated in Fig. 4, and a general view of the stocks is given from the seaward side in Fig. 5.

FLOW-PRODUCTION IN FITTING BASIN

Though four ships are under construction continuously, they are staggered so that no two ships are in the same stage of construction at the same time. Thus, except in very special cases, only one ship at a time comes into the fitting basin shown in Fig. 6. Ships under construction include 9,000 ton freighters for the Soviet Union and 10,000 tonners for themselves, and there is one presently on the stocks for Cuba. Last year they launched eight ships. This year they have built six ships to date, representing a total tonnage of 60,000 tons.

By the time a ship leaves the stocks, she is 40 per cent completed. As mentioned earlier, there is accommodation for four ships in fitting-out, with fitting taking place in series so that the system can be considered in broad principles one of flow-production. Primary fitting is carried out at the first station; the machinery and so on are fitted at the second; and the third and fourth stations are concerned with painting and finishing details.

They look at the arrangement as if it were a floating conveyor with the work being carried by indexing stages from one station to the next. There is no duplication of work at any of the fitting stations, except in the event of two ships having to be produced simultaneously, which is rare, or in the event of a ship returning from trials for further attention. In such an event, the system is sufficiently elastic to allow two ships to be tied up at any one of the fitting-out stations.

NO SURPLUS STOCKS HELD

Virtually all the components used in fitting-out are brought in from other specialized factories. Many of them arrive as complete prefabrications and can thus be regarded as sub-assemblies. It is the general policy to restrict the yards to building ships and to eliminate all subsidiary manufacture. The yard's chief production engineer, in fact, defined its purpose as being "purely a ship assembly factory."

The majority of bought-out items are made in East Germany herself, but some come from other countries. Plate is imported from the Soviet Union and many of the instruments from Czechoslovakia, with West Germany getting a fair proportion of the orders for navigation instrumentation.

Of some interest is the fact that this policy of construction allows them to minimize on stocks held. The sheds adjacent to each fitting station carry only the absolute minimum of stocks. It is the general practice to hold stocks only for the ships actually under construction, orders being so timed that the necessary bought-out equipment is received only as each ship comes off the stocks or proceeds to any of the subsequent fitting-out stations.

The general policy in East German yards is now to provide facilities for three phases of ship-building with the prefabrication section as it is now, followed by the fitting-out section and additional floating dock facilities.

There will be two floating docks at Warnemünde, both with capacity for 12,000 ton vessels. The first has already been built and is seen in Fig. 7. It is not yet in its final position and, at the time of the visit, its basin was still being dredged. The second floating dock is planned for completion by 1965. Thus, the East Germans are planning well ahead.

FUTURE PLANS

In common with all countries in the COMECON mutual economic aid plan, there is ever-increasing emphasis on rationalization and standardization. At Warnemünde, though they have already standaridized to a very considerable degree, they are by no means satisfied. They see, in further developments along these lines, the possibility of increasing productivity tonnage without requiring any additional state investment, and the attainment of what they believe to be their ideal for the future—yards which, as their chief production engineer said, will be truly and absolutely flow-production enterprises engaged solely in the assembly of prefabrications and bought-out sub-assemblies into sea-going ships.

Fig. 6 Flow production is used in the fitting-out basin, so that the ships pass from station to station in a continuous sequence.

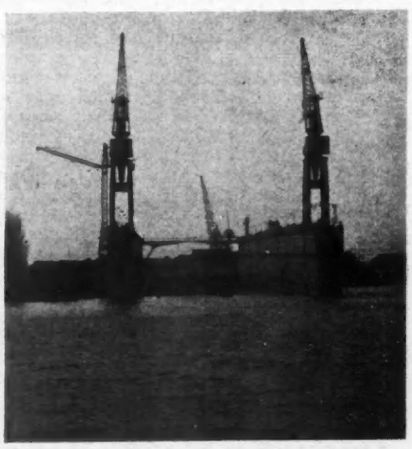


Fig. 7 Floating docks can accommodate vessels up to 12,000 tons. The first dock, seen here, is completed but is not yet in position.

New Concrete Dam Forms for Wide Valleys

More and more dams are being built in wide valleys where the concrete gravity dam is uneconomic and the simple arch dam inappropriate.

STEADILY increasing demands for the conservation and supply of water, and for power, combined with the fact that most valleys of promising shape—V-shaped with steep rocky sides—have already been closed by dams, have created the need for building dams in wide valleys. Where the barrage height is moderate, earth or rock fill dams may be preferred, but there are many conditions that may make a concrete structure more worthwhile. Efficient spillways, sluiceways and turbine water discharge systems are better constructed in concrete; and where the storage height becomes considerable or the width of the valley large, the mass of earth or rock dams may become so large as to make them uneconomical.

The problems involved in the design of concrete dams for wide valleys—where the ratio of width to height, or aperture, is greater than four or five—was one of the four principal problems discussed at the seventh International Congress on Large Dams held in Rome at the end of June (see also ENGINEERING for 30 June, p. 894, and for 21 July, p. 74).

REDUCING TENSILE STRESSES

From the papers submitted it is clear that the concept, design and construction methods for solid gravity dams are at present stationary. On the other hand, such structures are necessarily massive, so that for anything above moderate heights they involve handling great quantities of materials and may impose considerable loads on possibly weak underlying strata.

Arch dams for wide valleys have been very fully investigated. Until recently the largest arch dam built in a wide valley was Gibson dam in the USA, completed in 1928; it is 200 ft high and the apperture 3·6. Since then however valleys with higher apertures have been closed by concrete arch dams and examples were quoted in excess of 10, though in these cases all the structures were of quite low heights.

As the aperture increases, and assuming that attempts are made to keep the stresses in the arch constant, the " cantilever " bending stresses increase until the point is reached at which they exceed the compressive stresses due to gravity and tensile stresses develop at the upstream heel of the dam. A direct solution of the problem is to reduce the aperture of the dam by constructing artificial concrete abutments; this practice has frequently been adopted.

In dams of small aperture it is sufficient to provide an upstream overhang to the lower portion of the structure to eliminate or reduce the stresses at the foot of the cantilevers to an acceptable figure. As the aperture increases this solution is unsatisfactory, for the overhang reaches such as size as to cause tensile stresses downstream, possibly to such an extent that a supporting structure would be required if the reservoir were emptied. Under these conditions three solutions have been devised for high aperture dams to reduce the upstream tensile stresses: increase the thickness of the wall at either the lower levels or at the upper levels, or provide hinges at the base.

The effect of thickening the base of the structure is to raise the bending strength of the cantilevers and to reduce the arch effect; as the width of the valley increases this solution provides a section approaching that of the mass gravity dam it was intended to replace. Thickening the crest reduces the deflections at the ends of the cantilevers—producing the effect of a propped cantilever—and therefore reducing the bending stresses at the heel. This technique was used at Kariba (aperture ratio, 4).

With regard to the shape of the cantilevers the general reporter concluded that it seemed advisable, as the aperture of the valley increased, to increase both the upstream overhang at the lower levels and the crest thickness. Analysis of such a section becomes complicated, but in any case the most satisfactory way of estimating the stresses is by the use of a model which can be modified in shape until acceptable conditions are reached. Thickening of the upper arches of a dam has the additional advantage of increasing the thermal inertia at that section, providing a further reduction in the displacements with a consequent increase in the arching effect. For very wide valleys the base also has to be thickened.

HINGES TO GIVE ARCH ACTION

The idea of incorporating " hinges " in the foot of the dam to eliminate tensile stresses depends on the concept that if cantilever action is unattainable then the dam must act as an arch, so long as the abutments are sound.

An extension of this idea was planned for the Generalissimo dam in Spain; there it was intended to use roller devices at successive elevations so as to completely remove the cantilever action. A theoretical study submitted at Rome by J. Veltrop (paper R 113) showed that two hinges of relatively small extent were sufficient to make any dam structure behave almost exclusively as an arch. Even one hinge was shown to have a very pronounced reduction, not only on the cantilever moment—and therefore on the tensile stresses—but also on the radial shearing stresses.

The original conception of the use of hinges was credited to the late Monsieur A. Coyne in the Ribou dam. Two hinges were used in this structure, which is quite a small dam 52 ft high; the crest length is just over 400 ft and the aperture 7·8. This is still believed to be the largest aperture for which such an artifice has been used. The hinges at Ribou consist of reinforcements designed to take up all the radial shear but, in addition, the concrete surfaces within the hinge are keyed against shearing. The seals are made with copper sheets and bitumen.

The general reporter concluded his remarks in this respect by acknowledging the ingenuity of the Ribou design but asking why tensile stresses had to be eliminated at the cantilever bases, or, alternatively, to what extent could cracking at these sections be tolerated?

PRESTRESSED DAMS

As a different approach to the problem, there was some discussion on prestressed dams. The technique has been used for some years for heightening dams but recently a number of new dams have been constructed this way. Credit as the first prestressed dam was given to the Ernestina dam in Brazil (completed about 1951); this structure is 42 ft high and consists of a concrete plate prestressed by cables and built into the foundation rock.

The basic idea behind prestressing is that the load in the cables can directly replace mass in the equivalent gravity structure and the safety of a prestressed dam depends on three main factors. The first is that the cables cannot pull up either by coming away from the anchorage or by bringing a portion of the bedrock with them. In either case failure by overturning results. The second is that the cables should retain their strength throughout their life—this is a normal demand of all prestressed concrete and the necessary conditions are well understood. And third, arrangements must be made to minimize the possibility of corrosion of the cables, to be able to inspect the condition of the cables and, if necessary, to be able to replace a cable. Special attention has been given to all three of these factors in the Catagunya dam now being built in Tasmania. The work was described by Mr. G. T. Colebatch and Mr. J. K. Wilkins, both of the Hydro-Electric Commission of Tasmania (paper R 17).

The condition of the cables is to be checked electrically by testing a percentage of the cables at regular intervals. It is believed that it will be possible to detect a progressive deterioration in the cables and to take remedial action in good time. The tests will comprise the accurate measurement of the electrical resistance of the cables and changes of the order of 0·2 per cent will be ascertainable. For this purpse electrical leads have been connected to the top and bottom of selected cables and taken to the gallery where the observations will be made. As temperature variations within the dam will give rise to significant variations in the resistance of the cables, a precalibrated resistance thermometer, extending the full length of the cable, is also included in each installation. To eliminate corrosion every cable is being thoroughly grouted.

At the final session it was suggested that there was a fairly precise limit, for both technical and economic reasons, of 60 m (200 ft) on the height of prestressed dams.

Although no important development in buttress dams was reported, it was clear that attempts are being made in several countries to improve this type of structure. Efforts are being made not only to reduce the volume of the concrete but also to use simpler shapes for the buttresses, so that economies can be made in shuttering or sliding shutters used. It was pointed out by one contributor that in very cold countries, where the annual working period was short and transport frequently difficult, a reduction in the concrete volume was most important. In such circumstances, very thin but heavily reinforced sections were preferred, particularly because of their good behaviour under the temperature variations experienced.

MULTIPLE ARCH STRUCTURES

Though a number of qualifications were made concerning the stress distribution and elastic stability of the components of the buttress type dam, the investigations that have been made all tend to show that, so long as the usual construction rules are complied with, accepted methods of design are on the conservative side.

Multiple arch dams of the conventional type, with short spans between the buttresses, are seldom used at present. The most economical span has been found to be of the order of 65 ft and the arches have to be heavily reinforced because, due to the thinness, no cracking of the arch can be tolerated. It was thought however that one of the most promising solutions for concrete dams in wide valleys was the development of large-span multiple-arch dams. The argument runs as follows. If the spacing of the buttresses is increased, the thickness of the arches will also have to be stepped up, making it possible to use well known mass concrete methods and minimize the use of reinforcement.

The general employment of large-span multiple-arch dams is at present prevented by a lack of knowledge of the interdependence of the arches and the buttresses. It is not possible to state an optimum spacing for the buttresses in terms of the height of the structure. Nor is the best shape for the arch known. Model tests of a very fundamental kind are required in order that some approach might be made towards a sound design procedure. In the Erraguene dam, which is a multiple-span arch structure with 115 ft spacing between buttresses, extensive use was made of prestressing to reduce the concrete involved.

The problem is a very individual one for each site, involving not merely technical questions in respect of the dam structure, but also the supply materials and the construction technique most appropriate to the conditions. And in all cases, the dictating factor is the state of the underlying strata, particularly the depth of the bed rock.

Aircraft Hangars with Extensive Cantilever Roofs

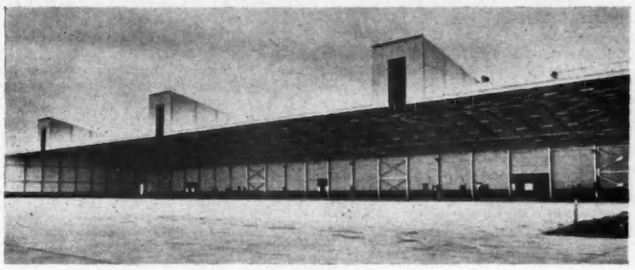
A new type of steel framed hangar has been introduced into the United Kingdom by the Anglo-American Hangar Company. The flying roof is supported by a series of repeated cantilever frames, as shown in the illustration. The advantage of the arrangement is that a hangar can be easily extended in length by the addition of frames; hangars can also be built back to back or, to provide a large span covered area, face to face. There is no limitation on a straight run and the design is easily modified so that buildings of L or even U plan-form can be constructed. Though originally intended for aircraft hangars, the buildings are equally well used for other purposes as, for example, a covered sports arena.

The steel members are standard British sections, shop fabricated by welding and site bolted. Simple purlins span between the frames and the covering may be of light alloy, corrugated steel or asbestos sheeting.

Advantage can be taken of the supporting columns of the frame to build office or workshop accommodation at the back of the building. As the roof is supported entirely from the rear section, no columns are required either along the sides or along the front of the structure. This allows doors to be hung for the full length of the structure, and along the sides, in such a way that all three sides of the hangar can be opened for the movement of aircraft in and out of the building. Typical spans for the roof are 120 ft to 200 ft with a height of 30 ft under the front of the roof, though heights of up to 50 ft have been built in America. The effective height can be increased by 15 ft by "tail gates" let into the fascia, as shown in the illustration.

The original design was made by the Erwin-Newman Company of Houston, Texas, and the illustration shows an early example of the hangars. This one, built for the Temco Aircraft Corporation of Texas, is 432 ft long, has a clear span roof of 120 ft and is 30 ft high, with the tail gates giving added height to 45 ft. Behind the shed there is a maintenance shop 40 ft wide running the full length of the hangar.

Anglo-American Hangar Company, 436 Grand Buildings, Trafalgar Square, London WC2.



In this hangar, cantilever roof construction provides a clear working space of 432 ft by 120 ft wide without internal columns.

Higher Steel Stresses in Concrete Road Bridges

The Ministry of Transport have revised their specifications to permit the use of cold-worked steel in bridgework at stresses appropriately higher than those for mild steel. The changes are given in Memorandum No. 785 *Permissible Working Stresses in Concrete and Reinforcing Bars for Highway Bridges and Structures* (HM Stationery Office, 6*d*). The recommendations have been endorsed by the Road Research Board.

The new provisions supersede the relevant sections of Memorandum 577 and the passages on permissible stresses in steel for type HA loading are as follows.

For all reinforcement of mild steel to BS 785, the permissible stresses in tension and compression should not exceed 18,000 lb per sq. in for bars of all sizes, up to and including the maximum size permitted.

For cold-twisted steel bars to BS 1144, and for deformed bars of high tensile steel with a guaranteed yield stress, the permissible stress in tension should not exceed half the guaranteed yield stress or 30,000 lb per sq. in, whichever is the less. The maximum permissible stress in compression should be half the guaranteed yield stress, but not more than 23,000 lb per sq. in.

When the reinforcement is of steel other than mild steel and when the stress exceeds 18,000 lb per sq. in in tension, the arrangement of steel determined from stress calculations should be checked for crack control purposes by applying the following formula:

$$T = \frac{n\, l_a\, E_s \sqrt{D}}{Z f_s}$$

where

n = number of tensile bars in the section; where bars in slabs are uniformly spaced, n is equal to 12 in divided by the distance between centres of adjacent bars in inches;

l_a = lever arm in inches, measured to the centroid of the steel;

E_s = modulus of elasticity of the steel in lb per sq. in;

Z = section modulus in in^3 of the whole section with regard to the edge that is in tension, as if it were plain concrete; for slabs, a 12 in width is taken;

f_s = steel stress in lb per sq. in at cracked section, at the centroid of the steel;

D = diameter of the reinforcing bar in inches.

The minimum acceptable values of T are given in inch units in the accompanying table. Where the bars in beams are of different diameters, the calculations should be carried out for each group of bars with the same diameter, and the values of T added together. This approach to crack control is based on a practice which has been followed in Sweden for some years; the minimum values of T are based on current knowledge, but some research is proposed to establish the best values for British conditions.

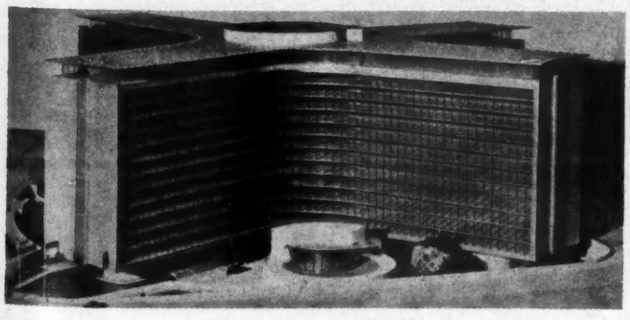
The memorandum, which also gives some amending clauses in respect of concretes for highway structures, has been compiled by a panel convened for the purpose by the Bridge Committee of the Road Research Board. The chairman has been Sir William Glanville, the director of the Road Research Laboratory.

	Deformed bars	Cold-twisted steel bars
Dead load	105	140
Dead load plus live load ..	70	90

Multi-Storey Building Suspended From the Roof

Site clearance and foundation work has begun on the new Centre Administratif de l'Europe in Brussels. Because of a height limitation of 55 metres only 13 storeys are possible above ground and it has been found necessary to provide a basement on four levels to obtain the required floor area.

The building is of cruciform shape with a central reinforced concrete core from which the wings radiate. Each wing is supported by a pillar at the opposite end, the largest of the four wings having two pillars. A central spine of steel girder construction runs the length of each wing and from frameworks at the level of the thirteenth floor cables will be suspended to support the lower floors on both sides of the spines so that the whole system is in balance. Expansion of the cables will be minimized by enclosing them in an insulated casing and the very substantial thirteenth floor will form a base for constructing a helicopter landing strip.



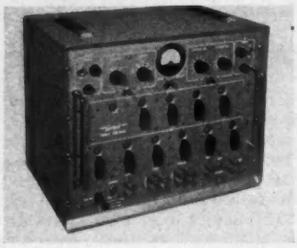
The top storey of each wing of this building spans between the central core and the end columns, and the 12 lower floors are suspended from the top. This has been found to give flexibility of layout and reduces the number of supports to a minimum.

The suspension technique is a departure from tradition and allows the building to be carried on the smallest number of supports. It possesses advantages in that it economizes in space, allows greater flexibility of the general arrangements of the building and facilitates maximum advantage to be taken of prefabrication. The general layout is shown in the illustration, the greatest length of frontage being 160 metres. Altogether, 23,000 square metres of glazing will be used and more than 2,000 rooms will provide about 40,000 square metres of office accommodation, served by a total of 26 lifts.

The below ground facilities include the provision of two halls measuring 94 and 65 metres by 16 metres, sundry offices and committee rooms, telephone exchanges, and a canteen with seating for over 1,000. One basement wing contains parking space for 1,600 cars distributed over the four storeys, access being by means of ramps. The location of the general services is below the central core where there will be an electric substation, air-conditioning apparatus and lift motors. All equipment is controlled from a central control room.

RATIO BRIDGES

With Phase Shift Measurement



NOW available are two Wayne-Kerr—Gertsch complex ratio bridges, the CRB-1B and CRB-2B, for precise measurements of in-phase and quadrature voltage ratios of three and four terminal networks such as transformers, synchros, resolvers, gyros and transducers.

The instruments also measure the phase shift angle between 0° and 1° or 0° and 10°, and the phase shift angle tangent.

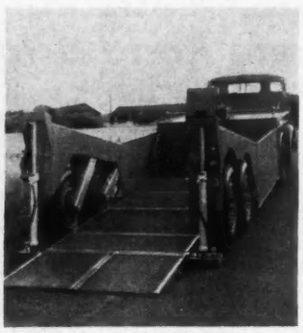
With an accuracy of 0·001 per cent, six-place resolution and requiring no external calibration sources, the new bridges function over the frequency ranges 30-1,000 c/s (CRB-1B) and 50-3,000 c/s (CRB-2B). Readout of transformation ratios is directly from digital switches in terms of rectangular coordinates, tangent, or phase angle between the voltages involved.

The basic circuit for the measurement of ac voltage ratios is the same in both instruments: a Gertsch ratio transformer functions as the ratio arms of an ac bridge and the off-null voltage obtained during the balancing operation is fed to a high gain (× 500) amplifier. This unit provides a detector circuit enabling very small values of off-null voltages to be rapidly detected, the sensitivity of the null detector being 10 microvolts.

Other features of the circuit eliminate the effects of harmonic voltages, noise and quadrature voltages caused by phase shifts across the device being tested. Phase-reversal switches for both in-phase and quadrature voltages allow measurements to be made, without loss of accuracy, in any quadrant. Both instruments have a power input rating of 100 watts at 115-230 volts, 50-60 c/s. *Wayne Kerr Laboratories Limited, 44 Coombe Road, New Malden, Surrey.*

GROUND-LEVEL LOADING TRAILER

Hydraulic Positioning



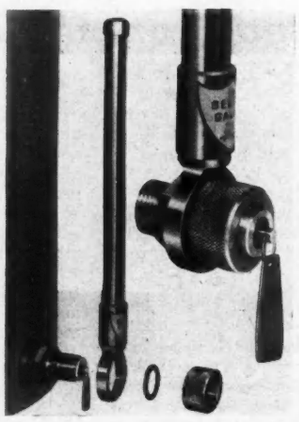
PRIMARILY designed for transporting fork-lift trucks, the Pitt L 15 10 ton capacity low-loading trailer incorporates interesting features for obviating the very long tailboard necessary for such equipment to mount a normal trailer. The unit has many other applications including site delivery of machine tools without using a crane.

A design incorporating rubber springing of the trailing beam suspension has given 5 ft 3 in between the wheelboxes; and by allowing the ends of these to be detached from the frame and lowered under hydraulic control, all the ground clearance is taken up, with a tailboard only 3 ft 4 in long. A pair of single-acting hydraulic rams fitted at the rear of the wheelbox, one on each side, allow the weight of the load to lower the chassis, elevation being from a hand-pump box and taking one minute. Ram operation may alternatively be from the prime mover, if specified. The loading attitude of the trailer is shown here. The rams are fitted with a locking device which gives additional safety in the running condition.

Hydraulic brakes on each wheel are operated from a two-line air pressure system. The frame is of four main member construction, stiffened in mid-span. A two-ton direct lift winch is fitted on the 7 ft 11 in upper deck; the lower deck is 18 ft long. Most makes of prime mover can be accommodated. *Pitt Trailers, Barton Stacey, Nr. Winchester, Hampshire.*

LIQUID LEVEL GAUGES

Demountable



TO MEET the increasing demands in domestic heating installations, a new liquid level gauge, known as the "Snapsafe," has been designed and developed. It incorporates safety provisions and facilitates its own maintenance by permitting removal in what is claimed to be a unique way.

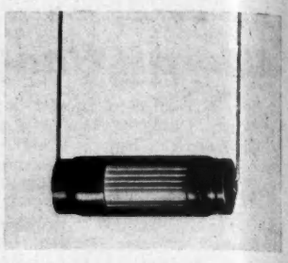
This model falls into the lightweight category, yet is fitted with a special spring-loaded pull button valve which only allows liquid into the gauge when manually operated at the time of the gauge reading. It also shuts off the contents of the tank from the gauge sight tube when not in use. An outstanding feature is that the gauge can be removed for cleaning while the tank remains in service; it can be refitted with equal ease.

The pull button mechanism reduces the possibility of jamming in the open position. The valve itself is buried deeply in the gauge mounting body and well behind the gauge collars, thus being protected from external interference or damage. The sight tube is made of a clear and unbreakable plastic material and is provided with a special plastic strip giving optical magnification.

This unit is produced to suit ½ in BSP tank bosses and is supplied in polished aluminium and cadmium-plated steel in standard lengths of 3, 4, 5 and 6 ft. *Seetru Limited, 43 Corn Street, Bristol 1.*

PHOTOCONDUCTIVE CELL

Cadmium Sulphide Type



NATIONAL Semiconductors Limited, of Montreal, announce the introduction of a new cadmium sulphide photoconductive cell, NSL-33, for photometric applications, particularly where low light levels and low voltages obtain.

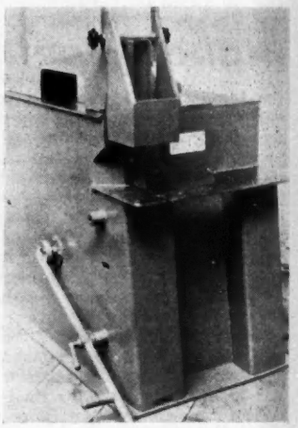
The spectral response of this stable ohmic photo-cell resembles that of the human eye, and the recommended illumination range is from 0·01 to 1,000 foot-candles. It is stated to be 1,000 times more sensitive, and also more powerful, than selenium cells of equal area which are used in all existing exposure meters.

The NSL-33 cell can be used for television brightness and contrast control, and in any light measuring device—photometers, exposure meters and automatic cameras. The temperature coefficient is unusually low for this type of cell and there is virtually no "dark adaption" or "light fatigue."

Cylindrical in shape, the cell has a curved rectangular window; the units are hermetically sealed in a dry atmosphere, glass-to-metal. Dimensions are 1·25 in long by 0·354 in diameter. The window dimensions are 0·5 in by 0·37 in, and the area of sensitive surface is 0·60 in by 0·25 in. The terminals consist of pigtails in No. 30 stranded tinned copper, 4½ in ± ⅛ in long, and plastic insulated. The ambient temperature range is from − 30° C to + 70° C and spectral response is C-1B. Time response to decay from 100 ft-c to 0·0 ft-c levels is 8 sec maximum. Dark resistance is 0·2 megohms minimum, and the power rating is a maximum of 0·2 W. Sole agents in the UK: *Hird-Brown Limited, 244 Marsland Road, Sale, Cheshire.*

CUTTING MACHINE

Rapid and Versatile



KNOWN as the Neva-Scimitar, this machine has an unusually high rate of cutting, and it is claimed by the manufacturers to be suitable for every kind of workshop, being capable of handling round or square bars, tubes, channels and sheet metal.

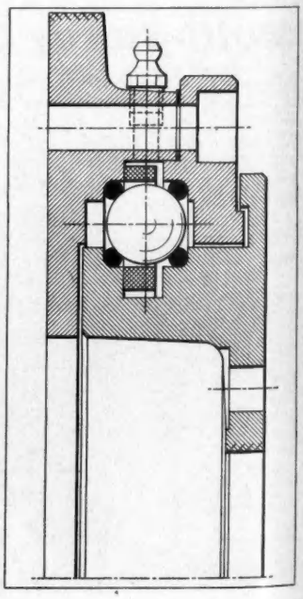
The machine is said to cut light and heavy gauge bar, strip, tube and sheet—in steel, plastics and non-ferrous metals—in a few seconds, the example being given of 2 in by 2 in by ⅛ in angle-iron being cut in less than two seconds to maintain a rate of 1,500 cuts per hour. Incorporating safety features, the unit is powered by an 8 hp 400/440V, 300 rpm motor.

Capacities for the machine are given as: rod or bar up to 4 in in diameter, tube up to 4 in, heavy sections up to 6 in by 4 in, strip up to 20 in by ½ in, and sheet metal up to $\frac{5}{16}$ in thick by any size.

Equally high speed mitre cutting, shortening, groove cutting, notch cutting and profile cutting of angles in sheet metal represent further facilities. Cutting is described as smooth, clean and distortion-free and accompanied by very little generation of heat. Dimensions are 4 ft 6 in by 2 ft 8 in by 4 ft 6 in high. *Anderston Clyde Engineers Limited, Irk Vale Works, Chadderton, Lancashire.*

BALL BEARING

With Wire Race



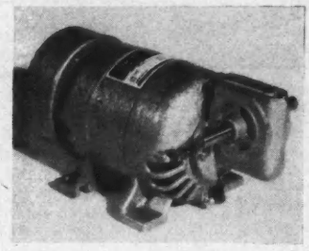
A NEW range of inexpensive precision bearings in six sizes from 18 in to 40 in diameter is announced.

Specially rolled flanged ring sections of medium carbon steel are used, and the ball races, instead of being flame hardened on the base metal, consist of high grade spring steel wires with spherically ground tracks, inserted in accurately machined grooves. This is claimed to provide an inherently rigid construction with four lines of contact, as seen from the section illustrated here. Accuracies of the order of 0·002 in radial and axial runout can be maintained.

A conventional housing is not required, the bearings being mounted by bolting through the flanges to a machined surface. Typical applications are in indexing tables for machine tools, unit head arrangements and spot welding machines, and rotating machinery for the manufacture of electric lamps and cathode ray tubes. *Roballo Engineering Company Limited, 43 Dover Street, London W1.*

FRACTIONAL HP MOTORS

Wide Torque Range



RECENTLY introduced is the first of a new range of fractional horse-power motors giving a wide selection of torque and output speeds.

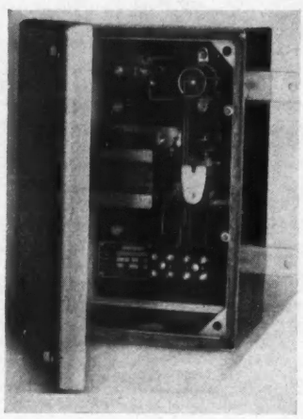
Manufactured to Class "E" BS 2757 (which allows a temperature rise of 65° above ambient), they are known as the GL8 (motor only), GL9 (motor with single-reduction gearbox—shown here with built-in capacitor), and GL10 (motor with double-reduction gearbox). They are available for single- and three-phase supplies and for various voltages: 1/30 hp at 1,400 rpm (nominal), 50 or 60 c/s, single phase 100/110 V, 200/220 V, 230/250 V, and three-phase 400/440 V.

All motors, both induction and commutator type, are supplied as standard for reversing, and without extra cost a new design of capacitor can be fitted to the rear end, or alternatively it can be separately mounted in the usual way. The motors may be easily mounted by foot or flange and are suitable for running in any position. The gearboxes can be turned to bring the output shaft into a variety of positions, and practically any final output speed can be supplied.

Shafts are ground to fine limits, and ball journals or plain bearings can be fitted in all frames without dimensional alterations. "Encapsulated" windings will be available in addition to the normal Class "E" BS 2757, rendering the units impervious to attack by moisture, oil, and most chemicals. Thus, an open drip-proof motor encapsulated in this way can often be used in place of a totally enclosed frame, obviating the need for a larger unit. All the rotating parts are statically and dynamically balanced electronically. *Comtex Limited, 566 Cable Street, London E1.*

AC LOAD DETECTORS

Saturated Choke Type



THESE detectors, Types KR/CH (illustrated here) and SSR/CH, are for use in ac circuits subject to very large current fluctuations; they will detect loads of fractions of an amp and will withstand the continuous passage of 25 to 50 amps.

A typical application is with diesel generator sets, where the detector unit is connected in series with the output of the generator and will shut down the set when all loads are switched off.

The units consist of a saturable choke working with a sensitive relay, operated by the voltage drop across the choke. Each unit also contains a rectifier and condenser, the whole being mounted on an insulated base and fitted in an industrial sheet steel dustproof casing with hinged lid.

The load is connected in series with a choke; a relatively small ac current provides a voltage sufficiently large to operate the relay and will not increase materially when load current rises. Voltage drop across the detector at maximum current values is approximately 7V. Standard units are for use on single phase supplies; units for 3-phase supplies can be manufactured to order. Types KR/CH and SSR/CH are available in 25 amp and 50 amp versions. *Londex Limited, Anerley Works, 207 Anerley Road, London SE20.*

COMMERCIAL OSCILLOSCOPE

High Sensitivity

KNOWN as the DuMont type 403-B Oscilloscope, this instrument is claimed to be the most sensitive oscilloscope commercially available.

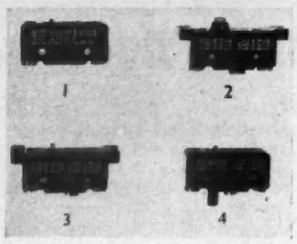
Its primary fields of application are in transducer readout, vibration studies, electro-biological research, noise evaluation, standard laboratory scope use, electro-cardioscope and electro-encephalograph practice, transistor research and micro signal detection and study.

A sensitivity of 50 microvolts per cm is available, with low noise level to permit resolution of signals as low as 10 μv. Phenomena that are barely determinable within a dc to 1 mc frequency range are easily detected and displayed by the instrument.

The degree of sensitivity permits display of non-amplified outputs from most strain gauges, pressure pick-ups, accelerometers, and other transducers. The instrument's 21 calibrated sweeps extend from 1 μ sec/cm to 5 sec/cm with a vernier providing continuous adjustment between steps, and the 5 sec/cm range is extended to slower than 25 sec/cm for a 250 sec maximum sweep duration. A single sweep mode permits only one driven sweep of the time base to appear on the cathode ray tube until the sweep is reset. *Aveley Electric Limited, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex.*

MICROSWITCHES

Combined Units for Many Applications



NOW being manufactured in the UK is a comprehensive range of Klickswitches (microswitches), and by combining many actuator sub-assemblies with the quartet of basic switches shown here, the manufacturers are able to offer a range of switches that will, it is claimed, cover most industrial and domestic applications.

The switches illustrated are: (1) Pin actuator side mounting; (2) Plunger actuator with side or cover mounting; (3) Pin actuator with side or cover mounting; and (4) Maintained contact model showing SPTD terminals and reset pin.

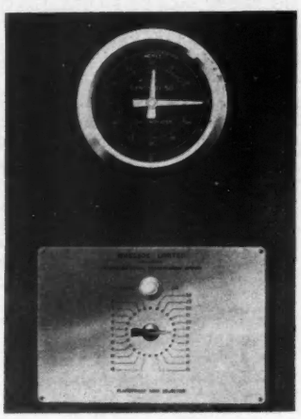
The Klickswitch is precision made and is stated to have a dependable snap action: it is built into a moulded phenolic case. This moulded plastic enclosure provides high resistance to vibration, corrosion and temperature change. The units possess good repeat accuracy.

A sealed enclosure type of unit is also offered, for use where it is necessary to exclude dust and moisture. These switches again have many different type actuators and actuator sub-assemblies, and they are expected to cover a wide variety of switching problems.

Catalogues are obtainable in the UK showing the complete range of Klickswitches together with a range of temperature, level and pressure control equipment (including control valves both electrically and pneumatically operated), ranging up to 16 in trim size, and all types of associated components. These are manufactured by General Controls' parent company, Glendale, California, and the German company in Dusseldorf. *General Controls Limited, 13-15 Bowlers Croft, Honywood Road, Basildon, Essex.*

REMOTE READING SYSTEM

For Tank Installations



THE Synchro 50 system of storage tank level transmission by electrical link can be fitted to the majority of tank gauges already in service. It is complementary to the manufacturer's S & J "Telepulse" system.

Two models are available, the Double Synchro 50, for custody transfer, which has an accuracy better than $\pm \frac{1}{16}$ in, and the Single Synchro 50, with an accuracy of $\pm \frac{1}{4}$ per cent, for control of pumping operation where high accuracy is not essential. All equipment is supplied in flameproof enclosures.

The Double Synchro 50 system comprises a weatherproof transmitter mounted on the tank gauge and containing two synchro units, and a repeater also containing two synchro units and including a dial gauge. The panel on which the repeater is mounted is usually fitted with a selector switch which enables the dial gauge to indicate the respective levels of several tanks, as shown here. A coarse pointer indicates feet, while a fine pointer sub-divides this reading to an overall accuracy of $\frac{1}{16}$ in.

The Single Synchro 50 system is similar in principle, but its transmitter and repeater are each provided with only one synchro unit. The repeater synchro operates a single pointer on the dial gauge. *Whessoe Limited, Darlington, Co. Durham.*

CENTRAL HEATING CONTROLS

Less Installation Work

A COMPLETE range of central heating controls is now offered, including a variety of weather sensitive and flow temperature instruments, which calls for less site wiring and installation labour.

Each of these units incorporates a built-in timer and the two adjusting knobs necessary for matching to the individual heating losses of the building. Once set, the units can be sealed and then any one of five heating programmes can be selected by switch. These programmes include night/weekend shut-off or depression, or extended day or night operation. Weather sensitive controllers are available for on/off or modulating systems, and a further model has been designed for the sequential firing of boilers.

Among the manufacturer's range of valves for operation by these weather sensitive controllers, or direct from thermostats, is an economically-priced mixing valve for water or other fluids, in sizes from 1½ in to 4 in. *Stonebridge Electrical Company Limited, 6 Queen Anne's Gate, London SW1.*

Molten Salt Systems

SEARCH for high temperature reactors with simple fuel systems has led to a renewed interest in the molten salt power reactor system. Although these reactors are attractive as burners of highly enriched uranium or plutonium, and as converters based on the uranium-plutonium cycle, the good neutron economy which can be obtained makes them potential breeders or efficient converters on the thorium-uranium 233 fuel cycle.

Advantages of the System

Molten salt reactors use fluid fuels in the form of solutions of UF_4, PuF_3, and ThF_4 in mixtures of lithium, beryllium, zirconium, sodium and potassium fluorides as carrier salts. The fuel salts are thermally stable to temperatures over 1,000° C and appear to be unaffected by radiation even at very high radiation levels; they are also compatible with graphite. The vapour pressures at 1,000° C are well below one atmosphere. Up to 800° C a new material INOR-8 (containing nickel for the base, with additions of molybdenum, iron and chromium) provides satisfactory containment. Uranium can be separated from the carrier salts by fluoride volatility processes, and preliminary studies indicate that simple fluoride based processes can be developed for the recovery and partial decontamination of the thorium, lithium, and beryllium salts. Fuels are reconstituted by dissolving fissile and fertile compounds in the carrier salts without metallurgical, ceramic, or mechanical fabrication steps.

Disadvantages of the System

There are three major problems in the molten system: the fuels melt at temperatures above 400° C, and so a fuel preheater must be provided to keep the fuels molten in the reactor piping systems; the fuels react with oxygen in air, water, and other compounds to precipitate fuel constituents as oxides, and care must be taken to prevent the fuel from becoming contaminated with oxygen-containing materials; and the radioactivity is in a highly mobile form and equipment which contains fuel becomes very contaminated.

Types of Reactors

Several designs have been suggested for large molten salt power reactors, including homogeneous reactors, in which the fuel salt fills the entire reactor vessel and the only moderation is by the light elements in the salt, and heterogeneous reactors, which contain 10 to 20 per cent by volume of fuel salt and 80 to 90 per cent by volume of graphite as moderator.

Both types can be conceived as two-region reactors with fissile material in a core which is surrounded by a fertile blanket, or as one-region reactors in which the fissile and fertile materials are combined in one fuel salt. The fuel can be circulated through the reactor and heat-exchanger equipment, or it can be retained in tubes in the reactor and cooled by circulation of a barren salt.

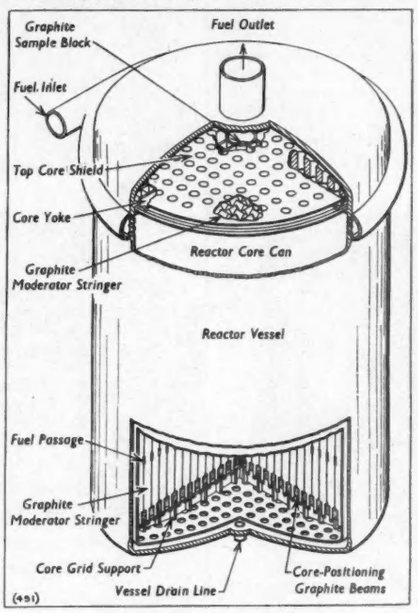
Fuels and Materials

The most promising thorium reactor fuels are solutions of UF_4 and ThF_4 in $LiF\text{-}BeF_2$ carrier salt. Molten lithium fluoride has good flow and heat transfer properties, and low melting points are obtained in mixtures with beryllium fluoride. The parasitic cross-section for the absorption of neutrons is low if the lithium is 99·99 per cent lithium 7.

Graphite is proposed for the moderating material and also in some designs as a container for separating core and blanket salts in the reactor vessels: thus it must not react with the salts, and must have low salt permeability and low permeabilty to fission product gases. The graphite now being produced contains about 15 per cent total void volume, but less than half the voids are interconnected and therefore inaccessible to penetration by liquids. Tests show that no reaction takes place between the fuel and graphite at the temperature proposed for the present molten salt reactors; this is largely due to the salts not wetting the graphite. However, it is thought that the development of pyrolytic carbon coatings will limit the penetration even further, which will be particularly advantageous for the fission product gases, since if these are allowed to diffuse into the pores the poison factor will increase considerably.

Details of the MSRE System

The constructional work has begun on a 10MW Molten Salt Reactor Experiment (MSRE) at Oak Ridge (Atomic Review, 18 Nov. '61) and



Reactor vessel assembly for the Molten Salt Reactor Experiment.

is scheduled for completion in July, 1963. The molten salt fuel is circulated through a cylindrical reactor vessel containing a graphite core matrix, as shown in the illustration. Under design operating conditions, fuel enters the core at 635° C and leaves at 663° C. It then flows at a rate of 80 litres per second to a sump centrifugal pump with a vertical shaft and overhung impeller, which discharges fuel through the shell side of the heat exchanger and back to the reactor inlet. Coolant salt is recirculated through the tubes of the heat exchanger and then through an air cooled radiator by a second sump type pump: it flows at a rate of 52 litres per sec and cycles between 552 and 593° C. Electrical heaters are provided on the pipeline and equipment of the fuel and coolant systems to keep the salts molten at all times. A liquid gas interface is maintained in the reactor fuel system in the sump of the pump. Fuel is bypassed through the sump at 3 litres per sec and the gaseous fission products in the bypass stream are transferred to a helium cover gas. There is a continuous flow of helium through the sump to the off gas system, and carbon beds in the off gas system absorb and retain the fission products until they have decayed. The coolant pressure is kept higher than the fuel system pressure to prevent any escape of fuel.

Fuel for the MSRE is a solution of $U^{235}F_4$, ThF_4, and ZrF_4 in $LiF\text{-}BeF_2$ carrier salt in the proportions 1 : 1 : 5 : 70 : 23 per cent molecule. INOR-8 will be the principal material used for the various circuits.

Spiral Flow

The reactor consists of a cylindrical vessel about 150 cm diameter and 230 cm high with an inner cylinder which forms the inner wall of the shell cooling annulus and serves to support the graphite matrix with its position and supporting members and flow regulating orifices. Fluid enters the vessel at the top of the cylindrical section and flows downwards in a spiral path along the wall. It loses the rotational motion in the plenum and then flows upward through the graphite core matrix. The matrix is constructed of 5 × 5 × 160 cm stringers of graphite which are loosely pinned to restraining beams at the bottom of the core. The core volume contains 77·5 per cent graphite and 22·5 per cent fuel. Three control rods will be installed and operated through the top of the reactor at the fuel outlet. A list of the main physical properties is given in the table.

The heat exchanger contains 165 tubes of 13 mm outside diameter and 4 mm long; the design is a conventional cross baffled shell and U tube configuration with tubes welded and back brazed to the tubesheet to reduce leakage between the fuel and coolant. Heat is rejected to atmosphere in a coolant salt-to-air radiator. Four tanks are provided for the safe storage of salt mixtures. There are two fuel drain tanks, a flush tank and a cool and drain tank. ("Molten Salt Reactor Systems," by R. B. Briggs, delivered at the Sixth Nuclear Congress in Rome, June 1961.)

Advanced Power Reactor

The graphite moderated circulating fuel reactor is favoured at present, because higher power densities and higher conversion ratios are possible in comparison with internally cooled reactors, and higher conversion ratio and smaller inventory in comparison with the homogeneous reactors. The conceptual design study has been made at Oak Ridge for an advanced power reactor. The reactor is of the two region design to produce 1,200 MW(t) and 500 MW(e). It will be surrounded by a graphite core 235 cm diameter by 235 cm high, surrounded by a 90 cm thick salt blanket and a 30 cm thick graphite reflector. The fuel heat exchanger and pump are mounted directly above the reactor to have a minimum volume occupied by radioactive equipment. The graphite moderator is an assembly of 19 cm square prisms about 220 cm long. Corners of the adjacent prisms are machined to form vertical passages of circular cross-section. The fuel salt flows in 90 two-pass bayonet tubes made of low permeability graphite, which are inserted into the passages. Regions between the core and the graphite reflector, and the annuli between the fuel tubes and the moderator are filled with blanket fluid which is maintained at a pressure higher than that of the fuel fluid. Thus if a leak develops, fertile material will enter the fuel stream and the reactivity will decrease. Fuel enters at 610° C at 3,200 litres per sec. and flows down through the annulus in the bayonet tubes at 6 m per second, rises through the inner tubes and is discharged to the outlet at 710° C. It then passes up through a duct to the pump and is returned through the tubes of the heat exchanger to the reactor inlet. About 270 kW of heat is removed for each litre of salt in the external circuit. By continuous processing, uranium in the fertile stream is kept low. Both the core and blanket fluid are cooled by a recirculated stream of sodium, and the heated sodium is used to generate superheated steam at 570° C and 120 atmospheres in an intermediate heat exchange system.

TABLE.—*Reactor Data for Clean Hot Condition, All Tubes Empty*

Fuel volume fraction in core	0·225
Core critical mass, kg U^{235}	15·6
Circulating-system inventory, kg U^{235}	47
Temperature coefficient of reactivity, $(\delta k/k)/°$ F	
Fuel	-9×10^{-5}
Graphite	-3×10^{-5}
	-6×10^{-5}
Mean neutron lifetime, sec	3×10^{-4}
Effective delayed-neutron fraction	0·0048
Total poison-tube worth (three tubes), per cent $\delta k/k$	4·6
Fraction of power generated in core	0·962
Per cent thermal fissions	86·6
Total power, MW	10
Peak thermal flux, neutrons/cm²-sec	$8\cdot1\times10^{13}$
Mean thermal flux, neutrons/cm²-sec	$2\cdot6\times10^{13}$

Companies

Twenty Five Years of Hawker Growth

EXTENDING from nuclear bombers to soft drink vending machines the industrial empire of the HAWKER SIDDELEY GROUP, now 25 years old, is a unique cross section of UK manufacturing industries, embracing some of the biggest headaches of designers and long term planners and some of the brightest growth prospects.

Reviewing the last 17 month account, the Hawker chairman, Sir Thomas Sopwith, reported a gross turnover of £458 million—when the group first made an annual report 25 years ago the total sales were £6 million. Reducing this last report to the equivalent of a 12 month account, the last year's turnover was £324 million, an increase of £64 million over the previous year and an indication that whatever the tendency for one branch of this industrial colossus to cancel out another, its overall growth is at a far greater rate than the average of British industrial production. It is not to be expected that this rate will go on. After the major absorptions a period of consolidation is expected.

Trading profits in the 17 months now reported on were £29 million, but of this £15·6 million were written off for design and development costs involved in major aircraft projects. And even this large total is only a portion of the amount spent on civil transport, the AWA Argosy, the Avro 748 and the new de Havilland Trident.

Two Engines a Week

A promising future is anticipated for each new aircraft. Ahead of these advanced and improved aircraft is certainly a time of fierce competition from other aviation interests whether at home or overseas.

On the industrial side of the group, the heavy electrical companies carried their activities to the highest level in their history. BRUSH ELECTRICAL ENGINEERING, at Loughborough, is producing large numbers of main line diesel electric locomotives for the modernisation programme of the BRITISH TRANSPORT COMMISSION. Repeat orders to Brush have lifted the total number of engines to 226 and deliveries through 1960 were running at the rate of 2 a week.

The same works is manufacturing complete power equipment for seventy 2,500 hp diesel electric locomotives which are to be built at the Derby workshops of the BRITISH RAILWAYS. Electrical equipment is also being produced at Loughborough for 154 diesel hydraulic locomotives to be powered by Bristol Siddeley Maybach engines.

Brush Electrical has been working closely with the Hawker Siddeley engine factories on a number of comprehensive electrification schemes overseas. Entry has also been made into the marine field with power equipment for the first British diesel-electric ship-handling tug, the Llanwern. After the success of this tug in service similar machinery has now been ordered from the company for four other vessels of varying types.

The other heavy electrical firm in the group is FULLER ELECTRIC, who have also been extremely active. Among their heavy transformer deliveries were two auto-transformers for the CENTRAL ELECTRICITY GENERATING BOARD'S Super-grid substation at Canterbury, Kent. Each of these units stands 25 ft, weighs 263 tons and is fitted with 132 kV fully-insulated high-speed resistor on-load tap changers of Fuller Electric design and manufacture.

The two largest rectifier-transformers in the world, for the British section of the Cross-Channel Power Link, have been built by Fuller Electric. The transformers will be installed at a substation at Lydd, Kent. Power to and from the national grid will be fed in and out through the Fuller-equipped Canterbury substation.

Perhaps the most completely diversified of the companies in the Hawker Siddeley group is Gloster Aircraft. This company's activities now include agricultural engineering, vending machines (*inset*) and the commercial vehicle market. The company has an agreement with the INTERNATIONAL HARVESTER Company for world wide marketing of its Gloster Forage Harvester. Its vending machine goes on extending the range and has a new hot-beverage machine and a multi-selection carton vendor.

Against the general trend in the group was the closing earlier this year of the HAWKER SIDDELEY NUCLEAR POWER Company factory at Langley, Buckinghamshire. A number of industries had been interested in a new process for the impregnation of graphite but the volume of work was insufficient to keep the factory working profitably. Work being done for the Atomic Energy Authority by other group factories is not affected.

Hawker Siddeley's exports from August, 1959, to December, 1960, were worth £56 million, a growing figure which is being vigorously worked on with an intensified export drive around the world.

Jubilee in Mineral Insulated Cables

The slightly downward trend in the new business done by PYROTENAX Limited, the mineral insulated cable producers of Hebburn-on-Tyne, has been reversed and the activity of the first few months of the current financial year now compares favourably with the average business intake of the immediate past year.

Another company celebrating its silver jubilee, Pyrotenax was incorporated in 1936 and began producing mineral insulated cables at Hebburn in 1937. Three years earlier, at Clichy near Paris, the first mineral insulated copper covered cable had been produced on a commercial basis by the SOCIETE ALSACIENNE DE CONSTRUCTIONS MECANIQUES. Having bought patents and manufacturing rights from the French licensors, Pyrotenax found demand for this type of cable growing rapidly.

Produced for the special purpose of providing a cable which would not cause or contribute to a fire and which would still operate successfully when passing through a fire zone, war time uses for such a cable were obvious. A shadow factory was equipped in Lancashire to meet the needs of the Royal Navy for high frequency cables to be used in radar installations, particularly on board ship.

Since the war new production processes have been introduced and last year an additional factory site in Hebburn was purchased. Some special cable production and development work has been transferred to the new factory.

In Canada and Australia the company has wholly owned trading subsidiaries each with their own manufacturing units.

Coinciding with its 25th anniversary the company's original manufacturing licence expires. By a new agreement with the original licensors Pyrotenax assume the world sales rights for products of the French, English, Australian and Canadian factories from 1 October, last year, excluding France and the United States, which are the subject of earlier agreements. The licensors are the Société Alsacienne de Constructions Mécaniques and LE CONDUCTEUR ELECTRIQUE BLINDE INCOMBUSTIBLE.

Parallel Working in Construction

Sharply reduced profit margins due to the now prolonged period of keen competition in the building industry meant that, as for other firms, margins were inadequate for HOLLAND & HANNEN AND CUBITTS in meeting the conditions of 1960, including the particularly bad weather in the later part of the year.

Progress, reports the chairman, Lord Ashcombe, in this annual report, was maintained satisfactorily on most contracts but with serious effects on costs. The result has been a fall in the net profit of the group (after providing for interest to outside shareholders in subsidiares) to £92,765, less than a third of 1959's net profit of £313,826.

Looking ahead, the construction industry will be concerned in the next few years with major programmes for new schools, university buildings, hospitals, housing, roads and other requirements of transport. In all these projects the keenest pricing is going to be essential and Lord Ashcombe points out that there must be thorough preparation and pre-planning by the authorities and their advisers and consultants.

The cost of mechanised equipment and of salaries and wages has now reached the level where economic working is only possible when a high and sustained volume of work is on the books. A solution suggested by the Cubitts chairman is that of parallel working.

This involves the close collaboration of the client, his advisers, and the contractor from the inception of the planning stage. The advantage lies in economic, reliable and swift completion. There is a growing use of early cooperation in planning but cases still occur where numerous delays, and changes demanded after work has begun, destroy the enthusiasm of those carrying out the work and dissipate their united effort.

Not all of Britain suffered equally from the bad weather of 1960. In the North there was rather less disruption and improved results were obtained by the North West and the Scottish companies.

The record turnover of the North West company included the glass research centre at Lathom for PILKINGTON BROTHERS is of particular size and interest. The company has also been responsible for Pilkington's new production buildings at Doncaster.

Among the important contracts of the Scottish company were factories in Dundee for MORPHY RICHARDS (ASTRAL) Limited and the NATIONAL CASH REGISTER Company.

Delays in receiving information and details have meant that the full advantage of the mild winter and the assembled plant facilities were not gained on the Hyde Park Corner/Marble Arch contract but the work is going ahead and completion on time is expected. This project is being handled by the consortium CUBITTS FITZPATRICK SHAND.

Power Consortium Starts British Guiana Work

A £2,500,000 project for the expansion of the electricity supply system in Georgetown, the capital of British Guiana, has entered the first civil engineering phase. The project is being carried out by a consortium of British companies, ASSOCIATED ELECTRICAL INDUSTRIES, INTERNATIONAL COMBUSTION (EXPORT) and TAYLOR WOODROW (OVERSEAS).

Taylor Woodrow are now constructing the foundations of a power station which is to be supported by piles because of swampy conditions. Generators for the station will be by AEI, boilers by International Combustion.

Should We Use Vinyl Paints in Britain?

In Canada, vinyl painting systems are giving good service on several waterway and hydroelectric projects. International Paints say they could be useful in the UK so long as good preparation is undertaken and painting can be done under cover or in good weather.

VINYL painting systems have been available in the United Kingdom since the end of the Second World War. Yet the number of sizeable applications in this country is very small. Why is this so? There is much practical evidence to show that, when properly applied, a vinyl coating will last five years or more, even in difficult conditions like protection of submerged steel in saline waters.

The illustrations shown here are taken from several projects on which vinyls have proved their performance in service in Canada.

When International Paints were asked for their comments on how vinyl paints were being used in the United Kingdom (their own system is called Vitaline), they answered as follows.

Vitaline paints were originally developed for marine use. Much of the large-scale work on which they have been used has involved either exposure to marine conditions or to fresh water (including severe ice conditions), but vinyl paints have other uses such as the protection of steel railway wagons containing corrosive cargoes. In addition to their low water permeability, the other attractive properties of vinyl paints include good chemical resistance, abrasion resistance, exterior durability and resistance to ageing.

Vinyl primers, finishes and antifoulings are not two-pack paints as are many specialist coatings. They are one-container lacquer-type materials which dry solely as a result of solvent evaporation. However, the self-etch primer or wash primer which is used as a pretreatment primer for vinyl schemes on all metal surfaces is a two-pack material.

This paint system is very good in cold climates such as exist in Canada. Good elasticity and general resistance properties are retained at very low temperatures. Yet this particular property is not really a great selling point in this country —mainly because of our climate. However, vinyl paints would be very suitable for certain specialist jobs where a surface coating is required on plant or equipment operating at low temperatures.

Vinyl paints must always be applied to dry surfaces; and, because the climate in Canada is more continental and regular and the atmosphere generally much drier than it is here, there are fewer difficulties in using vinyls on outside work in that country.

Vinyl paints are not expensive in themselves. The main reason why they are not more widely used in the United Kingdom at the present time is that it is essential for them to be applied over well-prepared shot-blasted surfaces. Moreover, best results are obtained if application is carried out by spray. It can be seen, therefore, that a contractor would have to possess a considerable amount of expensive capital equipment to apply vinyl paints successfully. If vinyl paints are not applied to very well prepared surfaces, or on outdoor work if weather conditions are unfavourable, adhesion to the surface will be poor and ultimately the film will detach.

Although vinyl paints have been available for a number of years, we have not gone out of our way to persuade people to use them because we have felt that generally the necessary standard of surface preparation would not be obtained and in many cases the application conditions might be unsuitable.

In recent years there has been a growing interest in shot-blasting, and technical developments in shot-blasting have improved efficiency. Our experience has shown that the best results on steelwork are obtained on surfaces which have been blasted with round steel shot BS mesh 30, although for site work the trend today is to use an expendable abrasive. Very satisfactory results can be obtained with certain of the silica-free grits which are now available.

There are a number of contractors who are quite capable of undertaking the surface preparation and application of high performance coatings on site, and they will probably grow in number and competency. A desirable change would be in the attitude of specifying authorities, architects, civil engineers and shipowners, many of whom still think of paint as an afterthought and not as a fundamental necessity.

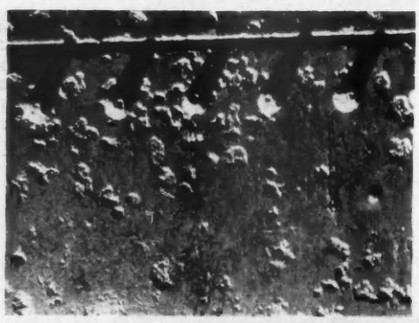
In manufacturing industries it is common practice to go to very great lengths to obtain ideally prepared surfaces before the application of a stoving paint. When a similar approach to the problems of surface preparation is adopted by those responsible for large contracting work, there will be a vast improvement in performance of surface coatings and full advantage can be taken of the exceptional properties possessed by high performance coatings.

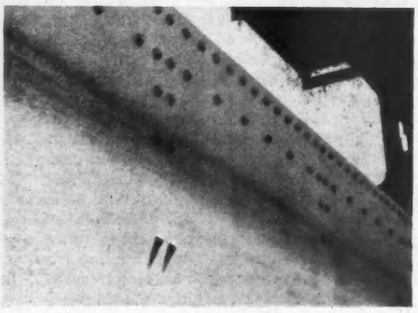
However, we would not advocate the widespread use of coatings such as vinyls, epoxies and polyurethanes on jobs where their special resistance properties are not required and where conventional coatings would be equally effective.

The uses of vinyls on the St. Lawrence Seaway project and similar projects in Canada and America have demonstrated conclusively the practical value of high performance coatings on large civil engineering projects of this type. In our opinion there are many uses for such coatings in this country providing satisfactory standards of surface preparation can be obtained.

International Paints Limited, Grosvenor Gardens House, London SW1.

Good blast cleaning is the key to getting good performance from vinyl paints, say International Paints; and this country is becoming increasingly geared up to undertake this work on site.

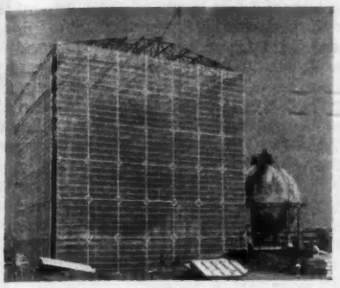




At first glance these surfaces of Canadian dam gates (withdrawn for inspection after three years immersion) may not look very promising. International Paints (Canada), who supplied their Vitaline vinyl coatings, comment otherwise: "Pitting occurred previously when the dam gates were coated with red lead in oil. In fact no breakdown has occurred as shown in these pictures. In particular (top left), caddis fly larvae have not penetrated the film, and (bottom right), the area which has been subjected to severe ice brasion is still undamaged."

Polyethylene Film Keeps Out Weather

To give weather protection to men erecting this butadiene storage sphere for ICI Heavy Chemicals Division at Wilton Works, a shelter made from polyethylene film has been built by Whessoe, who are the engineers making the sphere.



Each panel of the shelter consists of heavy-weight Visqueen polyethylene building sheet made by British Visqueen. A complete side of the shelter measures about 50 ft wide by 60 ft high. The structure is said by ICI to serve to isolate sparks caused by electric welding of the prefabricated sections of the sphere, and to allow day work to continue without the need for artificial illumination—unlike conventional tarpaulin sheeting.

Imperial Chemical Industries Limited, Millbank, London SW1.

Rubber Seals Help Sterilize Theatre

In a new design of operating theatre for hospitals, a self-sealing gasketing system made from synthetic rubber is considered to facilitate sterilization. The design is the work of New Electronic Products and is based on a modular principle. For this, the infill panels are made from foamed polystyrene core faced with aluminium and

coated with a finish based on Hypalon synthetic rubber or with other chemical resistant finishes. The panels are sealed to the framework and to each other by a system of corner strips and extruded gaskets coated with Hypalon. The extrusions themselves are reported to be made from a blend of three types of synthetic rubber, SBR, neoprene and Hypalon.

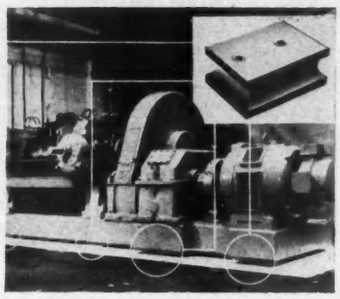
Du Pont say that this blend stands up to constant cleaning with mild deoxidising chemicals, disinfectants and steam. The same material has also been chosen for the door seal, double window seals, roof seal and hatch seals.

Du Pont Company (UK) Limited, 76 Jermyn Street, London SW1.

New Electronic Products Limited, 360 Kennington Road, London SE11.

Rubber Mountings for Heavy Machinery

Phoenix Rubber Company, who produce rubber-to-metal anti-vibration units, recently decided to use them when installing a new 60 in rubber mixing mill in their own factory. They were thus able to install this 22 ton mill on a 5 in bed of concrete compared with the 4 ft 6 in which they



say would normally be necessary for such an installation.

The mountings for this project were designed by their associate firm in Germany, Gesellschaft fur Technischen Fortschritt, MBH of Koblenz. Phoenix claim that using these mountings with correct advice, the engineering staff of an average factory can carry out similar installations with a considerable saving of time and money.

Phoenix Rubber Company Limited, Slough, Bucks.

Two Uses for Mineral-Insulated Cable

About 65 miles of mineral-insulated cables of special design have been supplied to the Midlands Electricity Board, according to the makers, British Insulated Callender's Cables. It is being used for a municipal building scheme in the Birmingham area which includes the construction of nearly 3,000 flats and dwellings and about 150 shops.

BICC collaborated with the MEB to take advantage of the copper sheath which, having equal cross sectional area to the inner core, serves as a second concentric neutral conductor. The copper sheath forms the return lead. Employed for rising mains and sub-mains and for lateral sub-mains in the new buildings, the cables are basically 440 volt single-core 0·0145 sq. in cables sheathed overall with pvc. Where the voltage drop was found to be critical, a similar type of cable having a 0·0225 sq. in cross sectional area was used.

A further use for mineral-insulated cable has been found in a new school in Scotland. It is called Kirkton High School and is wired throughout with nearly 30 miles of the cable as supplied by BICC. The installed electrical load is over 2,000 kW, the specifications for the installation having been drawn up by the Dundee area of the North of Scotland Hydro Electric Board.

British Insulated Callender's Cables Limited, 21 Bloomsbury Street, London WC1.

Ventilating Unit Uses Acetal Plastic

In this illustration can be seen a selection of parts moulded in Du Pont's Delrin acetal plastic for Vent-Axia. Du Pont say this is the first major United Kingdom application of the material in the field of domestic hardware.

The ventilating units, both window and wall-fitting models, are made in a range of four sizes with impellers of about 6, 7½ ,9 and 12 in diameter. Components of Delrin are used in both models and throughout the range of sizes.

Du Pont report that originally it had been decided to mould several components such as screws and clips in nylon, but when Delrin became available it was found that it was superior for moulding screwed components since it helped to maintain a stable thread diameter and gave little burring of the coin slots. It was later decided to use the same material for the iris

shutter blades and actuating ring.

Du Pont Company (UK) Limited, 76 Jermyn Street, London SW1.

Vent-Axia Limited, 60 Rochester Row, London SW1.

SG Iron Tundishes Last Nine Months

Tundishes of spheroidal-graphite cast iron are giving nine months' service before replacement at the non-ferrous metal foundry of the Delta Metal Company. Armstrong Whitworth, who make the tundishes in SG iron, say this compares with lives varying from a day up to three weeks obtained from heat-resistant and high-nickel content cast iron tundishes used previously.

The tundishes are supplied in the fully annealed condition and the first two to be tried weighed 3 and 3¼ cwt. When deterioration of these did set in, it was found that there was no tendency for small fissures which developed to suddenly become large cracks.

The SG iron tundishes are said to be similar in cost to those in heat resistant cast iron, and to be less expensive than high-nickel-content cast iron.

Similar experiences were met with the launders which convey molten metal to the tundish. The first launders in SG iron supplied by Armstrong Whitworth needed replacement only after 12 months. These launders have a bifurcated channel to direct molten metal between the three outlet points in the tundishes.

Armstrong Whitworth (Metal Industries) Limited, Close Works, Gateshead 8.

Delta Metal Company Limited, Tunnel Avenue, East Greenwich, London SE10.

Materials Handling and Covent Garden

Covent Garden is an anachronism in terms of materials handling and efficient layout. The Covent Garden Market Bill's proposal to rebuild the market on its present site is not a remedy that commends itself to the production engineer.

ONE cannot work for ENGINEERING, on the fringe of Covent Garden, without being aware that there is something rotten in the state of the world's biggest fruit and vegetable market. When it is one's job to try to record and signpost ways to industrial progress, a discordant note is struck by the view, in the street below, of Covent Garden porters pushing primitive handcart loads of fruit and vegetables to and from lorries which might be parked as far as half a mile from the market proper. The traffic chaos radiates much farther than that.

Although the market extends over 38 acres—originally it covered only three acres, but has been extended over the years by the piecemeal acquisition of unsuitable premises—its street activities are estimated to cover 99 acres and occupy 10 miles of kerbside. In a recent newspaper article, an officer of the Covent Garden Tenants Association estimated that up to 3,500 lorries use the market area daily during the peak season. Some of these lorries have to wait until 10 a.m., six hours after the market opens, to be unloaded.

As every production engineer knows, each time a product is handled its cost increases without increasing its value. In the case of foodstuffs of the type handled at Covent Garden and in the surrounding streets, one can go further and say that each time they are handled there is a positive decrease in value. Crude handling methods (even those cartoon characters nonchalantly balancing baskets on their heads seem to be myths) must stand a good chance of damaging foodstuffs and must certainly cause them to reach the shops later, and less fresh, than is possible.

TO MOVE OR NOT TO MOVE

The shortcomings of the market have been apparent for quite forty years. In 1921, a government departmental committee recommended the setting up of a London markets authority; in 1923, the Linlithgow Committee said, " the present facilities and layout are totally inadequate "; in 1928, the owners of the market premises tried to move to a more sensible site but were thwarted by local government protests; in 1943, a government committee called the market " an anachronism." Soon after the war, the removal of the market to another site was again mooted but the idea was dropped, partly because it was felt that the traders wouldn't move voluntarily with the market. There was also a reluctance to give up the commercial asset of the name, Covent Garden.

In more recent years, the growth of both traffic and trade has made the problem yet more urgent, and more serious attempts have been made at producing a practical remedy. In 1957 the Runciman Committee and the London and Home Counties Traffic Advisory Committee both urged government action, but while the former advocated rebuilding Covent Garden on roughly its present site, the Traffic Committee favoured removing it from Central London.

Now that the Government has belatedly taken some action in the form of the current Covent Garden Market Bill, it is clear from the Bill's treatment in the House of Lords and from correspondence in the press that there is wide dissatisfaction with the proposal that the market should be rebuilt on its present site. Supporters of the Bill say that the proposed Covent Garden Market Authority can come back to Parliament to have its terms of reference amended, if they think a new site is advisable, but the many of us who are bewildered by the sophistications of parliamentary procedure can see no point in not writing this provision into the original Bill. In its present form the Bill appears to prejudge the issue.

KING'S CROSS PROJECT

A particularly strong advocate of the view that Covent Garden should be moved lock, stock and barrel is Mr. C. W. Glover, who last month presented to the Royal Society of Arts a carefully prepared plan for establishing a new market at King's Cross. Others have recommended the same site but Mr. Glover, who first suggested it in 1930, is the real prophet of the idea. He now has the backing of a strong consortium, the Industrial Development Group.

As Mr. Glover told the Society, the Covent Garden problem is primarily a materials handling problem. Further, it is a problem which goes back much farther than the more obvious chaos in the vicinity of the market itself. Of the 24,000 tons of produce which are brought into, and distributed from, Covent Garden each week, about 12,000 tons come from overseas via London Docks or, occasionally, Southampton or another port. Thus, this produce has to be handled from ship to lorry (sometimes from ship to rail wagon to lorry), a costly and time-absorbing process, before it is caught up in the concentrated disorder of the market itself.

Going to the root of this problem, as a production engineer should, Mr. Glover states that a priority requirement for a central market carrying out the present Covent Garden market function must therefore be that it is accessible by every means of transport—road, rail, water and even air. Kings Cross is the one centrally located site which has—or could have, comparatively cheaply—this accessibility by all types of transport and could also be acquired without expensive compulsory purchase of land or high rentals or demolition of existing premises.

North of Kings Cross station there is a fan of terminal sidings extending over an area of 24 acres. To build a floor platform on pylons over the existing rail sidings would be a straightforward undertaking using modern structural techniques. In the recent House of Lords debate it was stated that the British Transport Commission has expressed a willingness to cooperate in any proposals for setting up a produce marketing centre at Kings Cross and to integrate these proposals with their own plans for railway modernisation.

Mr. Glover's proposal, therefore, is that a five-storey market building should be built on such a platform, providing a total floor area of 2,107,440 sq. ft in five warehouses and covering a ground area of 19½ acres. Bays on the ground floor would make possible the simultaneous unloading of 700 road vehicles, which would have easy access to the market along York Way, one of the main arteries to the north. Meanwhile, 200 rail wagons would be handled in five internal sidings on the first floor, an arrangement which is made possible by existing high sidings (at present unused) along one side of the goods yard.

On the opposite side of the goods yard from these higher sidings is the Grand Union Canal, which connects with London Docks and could be linked to the proposed market building by mechanical conveyors. The fourth transport medium—air—would be provided in a more *avant garde* way by a comparatively inexpensive heliport on the flat roof of the building. This could be used for direct transfer of the more valuable and perishable produce, the higher transportation cost being justified, it is claimed, by the reduction in wastage.

SWIFTER HANDLING

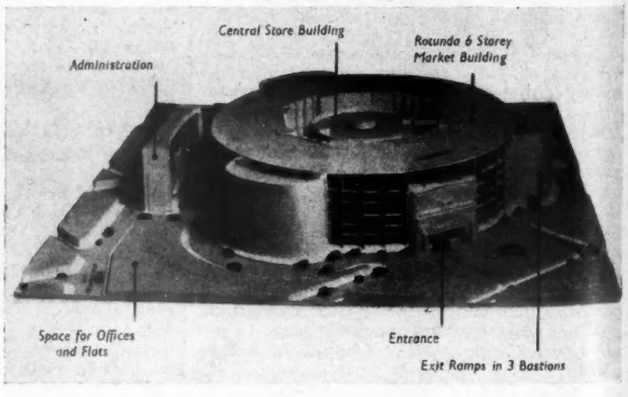
Within the building, speedy transfer of goods from bulk supply to store or conditioning rooms, and to display and retail dispatch would be by a system of trucks, hoists, conveyors, elevators and chutes, according to the type of produce. This system would prevent queueing of delivery vehicles, cut handling time and cost, and prevent damage and waste. Indeed, the handling rate at this projected market would be 5,000 tons per hour, compared with the 500 tons per hour capacity of the existing market.

Mr. Glover puts the cost of this project at something like £6 million, a figure which makes a favourable comparison with that already suggested for the rebuilding of the market at Covent Garden. In addition, of course, the Covent Garden site would be released for more eye-pleasing development. Further, even if the British Transport Commission were paid as much as £100,000 per annum in ground rent, the all-in rent to the tenants, it is calculated, would be less than they are now charged for unsuitable and fire-prone buildings on the present site.

Since the Covent Garden Bill prescribes a new market on 10 acres of the present site, Mr. Glover has also produced a plan for a building suitable for this purpose. This is an interesting project (shown in the illustration), involving a six floor building with an internal service road encircling the storage and display areas, but it would be a great pity if the proposed Covent Garden Market Authority does not insist on a completely new site with better transport facilities.

A " far out " theatre designer said recently that most British theatres need a " bloody great bomb " under them. Now that the government has become sufficiently " far out " to recognize that the biggest British market needs the same treatment, one hopes they will go further and recognise the unsuitability of the present site for its successor.

C. W. Glover and Partners, Francis House, Francis Street, London SW1.



As an alternative to the Kings Cross project, Mr. Glover has produced this design for a new market on 10 acres of the Covent Garden site. Storage and display areas are encircled by a spiral road giving, in six turns, one continuous floor at an incline of 1 in 100.

New 80 Ton Electric Arc Furnace Commissioned

An 80 ton Birlefco electric arc furnace, claimed to be the biggest in the country, has been commissioned this month by the English Steel Corporation in Sheffield. The furnace has a shell diameter of 21 ft and an electrical rating of 20 MVA, and is capable of melting a full capacity charge in less than three hours.

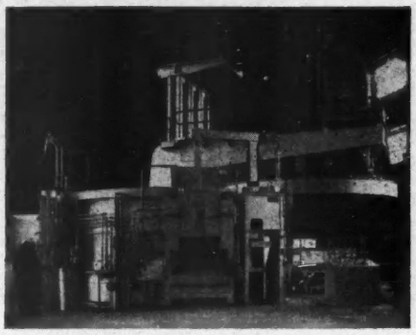
Power is supplied to the furnace by an AEI transformer, incorporating a resistance transfer on-load tap change mechanism suitable for arc furnace work, and a 10 per cent auxiliary reactor arranged for on-load switching is also provided to limit power surges during the initial melting down period. The main switch is a Reyrolle oil circuit breaker with a 750 MVA rupturing capacity, and specially designed water-cooled low voltage flexible cables carry current from the transformer to the furnace.

The furnace transformer secondary Delta is made on the electrode arms at the point of connection to the flexible cables, an arrangement which gives a minimum reactance and high furnace power factor particularly when the electrode arms are displaced away from each other. Each electrode arm is counterbalanced by means of four pneumatic cylinders, enabling relatively small motors to attain rapid accelerations and high speeds with a minimum of inertia. These motors are designed to operate with a well proved AEI amplidyne electrode controller.

A new feature of the furnace shell is that it is split horizontally in two halves just above the slag line, the upper half being detachable to permit quick replacement of the side wall brickwork. During this replacement operation, a spare upper half, already bricked, is lowered into position in a manner similar to that in which an arc furnace roof is replaced in conventional practice.

This furnace has been designed to produce special alloy steels for casting in vacuum, and, in conjunction with other melting furnaces, will make possible the production of vacuum cast ingots up to 180 tons in weight. These ingots will be extremely low in hydrogen content and forgings made from them will be particularly suitable for highly stressed components for the electrical, chemical and general engineering industries, and for other high duty applications.

There is in the melting and vacuum casting department a new overhead travelling crane which is equipped for handling the large ladles of molten metal from the new electric furnace. It has a capacity of 200 tons on the main hoist, and the auxiliary hoist has an independent crab of 50 tons capacity running between the main girders. The span of the crane is approximately 60 ft and it runs on a gantry 59 ft above the shop floor at rail level. It was supplied by Clyde Crane and Booth.



The new furnace shortly after being commissioned.

The introduction of the new furnace is part of an extensive development project which will eventually cover a floor area of 1 million sq. ft and increase English Steel Corporation production of alloy and special carbon steels to nearly 1 million tons per year. Under this project, a new rolling mill is scheduled to be operational by the end of 1962.

English Steel Corporation Limited, River Don Works, Sheffield, 9.

Making the First of the Supersonic Few

Security restrictions have now been partially lifted from the production lines of the English Electric Lightning mach 2 fighter. Work on this aircraft, the first supersonic fighter to become operational, has been technically the most advanced undertaken by the British Aircraft Corporation. Before the first production aircraft was built, three prototype and twenty pre-production Lightnings were used in an intensive test flying programme to clear the aircraft for service with the Royal Air Force.

However, so intensive was this pre-production development programme that the first production aircraft was completed in October, 1959, only eighteen months after the first pre-production aircraft flew. Manufacture of the Lightning is now shared between three English Electric factories at Preston, Accrington and Salmesbury, all within a few miles of each other in Lancashire. Nearly 10,000 people work in these factories and between 900 and 1,000 more are being trained each year.

The division of production between the three factories is that wings and front fuselages are made at Preston, while the main fuselage, fin and tailplane are built at Accrington. These sub-assemblies are then delivered by road to the Salmesbury works where the whole aircraft is assembled. It is then flown to the company's nearby test airfield at Warton for production test flights.

5,000 aircraft have been made at these factories since 1938 but, for Lightning production, they had to be tooled up for an aircraft far more compact and more complex than any built previously in Britain. An example of the problems peculiar to the Lightning is that the forward fuselage, containing the cockpit, radar, armament and flying aids, is only large enough for one man to work in it at the time when all this equipment is being installed. This factor increases the working time but, on the other hand, the aircraft is designed to utilise many of the existing machine tools and methods of construction. It has been necessary to counter the exceptional stress and heat conditions met in the Lightning by including in the production line new processes such as skin routing, titanium forming and the manipulation of stainless steel.

The sub-assemblies made at Preston and Accrington receive a complete electrical test and the double skinned fuselages are pressure tested before dispatch to Salmesbury. The fuselages are also put into a " turn-over " jig and given an audible test for loose fittings or foreign bodies.

At Salmesbury, the wing assembly is " married" to the main fuselage, as shown in Fig. 1, and then the complete fuselage is assembled, together with the fin and tailplane. The engines, mounted one above and slightly behind the other in the main fuselage, and the electrical wiring are also added. Armaments and radar equipment are " bought out " parts supplied by the Ministry of Aviation. Fig. 2 shows the main assembly line at Salmesbury.

Since the first pre-production aircraft flew, there have been many minor modifications and one fairly major one in the shape of a larger fin. The need for this larger fin was originally established by wind tunnel tests but was confirmed during test flying. A special production programme was then set up to provide the larger fin for all aircraft, including those already flying.

To provide sufficient space and skilled manpower for the large Lightning programme it has been necessary to reorganise the manufacture of other products at the three factories. This has involved transferring the entire contract for the Canberra PR Mk. 9 to Short Brothers and Harland at Belfast, while other Canberra work has been sub-contracted to Boulton and Paul, at Wolverhampton, and to Marshall's at Cambridge. The transfer of the main Canberra contract in this way is an example of the profitable interchange of facilities and experience which is now possible within the British Aircraft Corporation.

An interesting development of the Lightning is a two-seater trainer which first flew in May, 1959. This aircraft has a special front fuselage 11½ in wider than that on the standard aircraft to accommodate two seats side-by-side and complete duplicate controls. It is important, with such a revolutionary aircraft, that there should be two-seaters for pilot familiarisation. The jump from the Hunter type of performance to the Lightning has been a big one for pilots as well as for design and production staff.

The first Lightnings became operational with the Royal Air Force in May of this year. Development work continues and this month the first Mark 2 Lightning was successfully test flown from the Warton airfield.

British Aircraft Corporation Limited, 100 Pall Mall, London SW1.

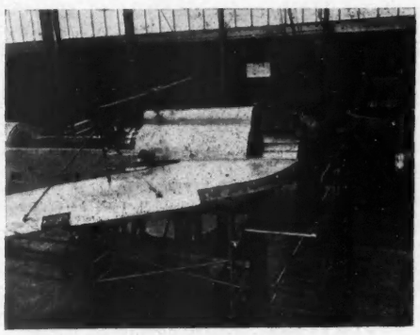


Fig. 1 " Marrying up " the wing assembly to the main fuselage. The upper of the two engines will later be fitted in the space on top of the fuselage.

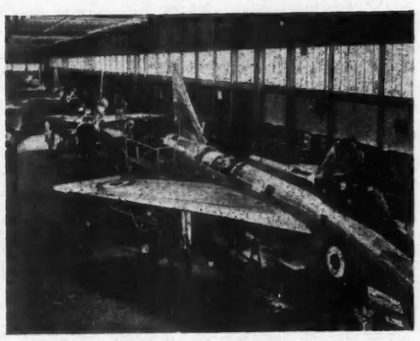


Fig. 2 The main assembly line at Salmesbury. Completed aircraft are flown to the nearby Warton airfield for test flying.

On the Shelf

By Frank H. Smith

ONE of the minor moans of us parents is that kids don't read enough. I am not surprised. Last term my twelve-year-old had, as set book, *Robinson Crusoe*. This term it is *Gulliver's Travels*, and two more difficult books to read it would be difficult to find. I know because I tried reading them aloud so that he would get the sense, but I could not even start to get the sense myself of some of the archaic language. Can it be that the fault is not in the children but in their teachers? Is it not bad enough that they should hate foreign languages because of the necessity to translate, without having the same feeling, from the same cause, for their own tongue?

First two numbers of the *Bretby Broadsheet* come from the National Coal Board, Central Engineering Establishment, Ashby Road, Stanhope Bretby, Near Burton-on-Trent (and, incidetally, as one nationalized body to another, the National Coal Board should know that the General Post Office does not like the word "near" incorporated in an address). The first number (March) says it is to be issued at regular intervals, and the second number covers April/May, so the regularity is anybody's guess. The second number has more guts than the first and deals with such matters as heading-out machine, Peake ripping machine, Dawson Miller Stablehole machine, Bretby vertical mixer and low-pressure stowing with Atlas Copco compressor. So if that's your cuppa tea, you now know where to get it. I'll stick to P. G. Tips.

As a memorial to 1 July (remember?—the day Wilson beat Fraser after 2¼ hours on the Centre Court) I dedicate the next two items. *Bibliography of Temperature Measurement*, covering January, 1953, to June, 1960, is National Bureau of Standards Monograph 27, by Halpern and Moffat and costing 15 cents from USGPO (or the sterling equivalent from HMSO); and *Heat Bibliography 1959*, compiled by the National Engineering Laboratory of DSIR, is obtainable from HMSO at £1. I have not seen the first, but the other is a quid's worth of paper apart from all the scholarship in it. 404 pages jam-packed with references divided into 51 general subject headings which, in turn, are sub-divided into more specific ones, in abc author order. No silly confusing numbers.

I had occasion to write to the ASME recently for a paper, and they sent me back their June list of papers. An imposing list, certainly, but the important thing as far as we are concerned is that there is a change of address. After August, 1961, orders for papers (and payment) go to 345 East 47th Street, New York, 17. This seems a great pity to me after so many many years of 29 West 39th Street. There was a hint of poetry in that, that even 77 Sunset Strip cannot rival.

A useful list of books on *Textiles* (and that is the title of the booklet) is obtainable from the City Librarian, City of Nottingham Public Libraries, South Sherwood Street, Nottingham. This does not come as a surprise from the city of old lace (without the arsenic, I hope).

Newsletter No. 12 of the Aslib Electronics Group has a supplement inviting your vote on the continuance of UDC numbers in *Science Abstracts Part B* (there's a threat of their cessation—the numbers, not the abstracts). If you feel strongly, ask Mrs. E. M. Codlin, Librarian, GEC, Applied Electronics Labs., Stanmore, Middlesex, for a voting form.

Trans World Airlines send me a list of freight rates as of 1 September. The very first item is for "Foodstuffs, Spices and Beverages, N.E.S., excluding Caviar." This strikes me as the nicest and most refined bit of discrimination I have seen for a long time. Unfortunately, this sample list does not include tools, but I'll bet it runs through the whole chest and finishes "excluding hammers and sickles."

Transistor Troubles

Transistors: Circuits and Servicing. By B. R. A. BETTRIDGE. 2nd Edition. *Trader Publishing Company.* (3*s*)

The author has written this booklet mainly for the radio service engineer to explain the properties of transistors and the conventional circuits in which they are used. The transistor radio industry has expanded rapidly during the past five years and there is therefore a growing demand for the servicing of such sets. When a service engineer understands these properties and circuits he should feel competent to remedy most of the faults which might occur in such a receiver.

The first chapter of the book manages to explain the electrical properties of transistors in a logical manner without wading into any complicated theory or mathematics. The author then continues by explaining the three basic configurations: common emitter, common base and common collector, comparing each with the analogous value configuration.

The configurations most used in radio receivers are the common base and common emitter which are dealt with more fully in chapters two and three respectively. Current and power gains are explained and a practical example using each of these configurations is given. It can be argued that the example of an i.f. amplifier operated in common base is out of date, but this example is still useful in outlining the principles which are usually used for high frequency r.f. stages. The example for common emitter operation is very valuable since the majority of transistors used in transistor radios operate in this manner.

Chapter four deals with audio amplifiers with special reference to class B push-pull output stages which are widely used in portable receivers because of battery economy.

Chapter five acts as a very complete form of summary, systematically working through two commercial transistor a.m. portable receiver circuits. These circuits are taken stage by stage and special points not dealt with in the previous chapters such as frequency changers, neutralizing and automatic gain control are elaborated on. A similar description is then given for a typical circuit for a transistorized f.m. receiver which might be encountered by the service engineer during the next few years. Again the author appears to be rather pessimistic about the use of common emitter i.f. stages, especially since these have been recommended by most transistor manufacturers.

The final chapter deals entirely with fault finding, indicating how to find the faulty stage, and how to remedy it, pointing out the precautions which should be observed so as not to damage the transistors.

This book should prove very useful to the service engineer who is not yet familiar with transistors.

H. A. HEINS

Low Temperatures Trap Free Radicals

Stabilization of Free Radicals at Low Temperatures. Edited by ARNOLD M. BASS and H. P. BROIDA. National Bureau of Standards Monograph 12. *US Government Printing Office, Washington, DC; HM Stationery Office, London.* (13*s* 6*d*)

In 1956 it was realized in the US, and elsewhere, that if free radicals could be trapped and stabilized in some way, they would possess considerable latent energy. If this energy could be suitably released it would be possible to use it to drive space vehicles. Because of this interest, a three year research programme was initiated at the National Bureau of Standards, sponsored by the US Department of Defense. At the end of the programme, in September, 1959, the Fourth International Symposium on Free Radical Stabilization was held in Washington. The present volume collects together the eight review papers that were presented at this symposium, covering the work of the research programme at NBS. There is also a paper summarising the whole symposium, as well as a bibliography of articles published by members of the NBS team.

The organization of the NBS programme was somewhat unique and is described in the first paper. Scientists were drawn from the NBS, from universities and from industrial research establishments, mostly in the US but some from Europe and Israel. The programme was led by Dr. H. P. Broida who allowed the scientists to choose their work, freely, in the framework of the programme. Communication among the scientists and between them and outside organizations was greatly encouraged.

The freedom of choice of work is reflected in the wide range of subjects discussed in this book. The method of trapping radicals that was fundamental was freezing at low temperatures, usually 4° K or even lower. It may be said at the outset that no method tried gave solids containing more than 1 per cent of radicals. However, much fundamental information was gained on the behaviour of low temeraturep solids and of radicals generally. Another outcome of the work was considerable development of methods for handling low temperature fluids, like liquid helium and liquid hydrogen.

One of the early phenomena that had been noted was the blue-green light emitted by the solid formed when nitrogen was dissociated in a discharge and collected on a surface at 4° K. The light emissions from this solid received attention from many spectroscopists and the behaviour of the material was also studied by electron spin resonance (ESR) spectroscopy and by calorimetric techniques. The presence of nitrogen atoms was shown conclusively and many other interesting features were also discovered.

Attempts to mix beams of radicals with inert matrix materials, such as argon, and condense the mixed gas at low temperature did not yield any higher concentrations of radicals than other methods. Another interesting means of stabilizing hydrogen atoms was the use of strong magnetic fields to separate beams of atoms having different electron spins (Stern-Gerlach effect). While two beams of hydrogen atoms could be obtained, in each of which the electron spins were all the same, few of the atoms survived when they were trapped on cold surfaces outside the magnetic field; the concentrations of trapped atoms were no higher than those obtained in other experiments.

In addition to work on the trapping of radicals, interest in low temperature chemistry was roused during the programme. The simplest experiments were those in which gases, passed through electric discharges, were mixed close to a surface cooled by liquid helium. Some otherwise unstable products were formed. Other work of this type was the reaction of organic radicals such as methylene with various solids cooled to 4·2° K, and the photolysis of hydroxylamine and hydrazine at temperatures below 100° K. Probably the most interesting technique was that developed by Drs. R. Klein and M. D. Scheer who dissociated hydrogen gas in a closed vessel by means of a hot tungsten filament. Propylene was condensed on the walls of the vessel, which were cooled in liquid nitrogen, and reactions between the hydrogen atoms and the propylene were observed.

The apparatus developed for rotating a vessel containing liquid helium in a vacuum and depositing various materials on its side is of some engineering interest.

In addition to the reviews of the practical

work carried out at NBS, there are papers of somewhat more theoretical background. One of these outlines some of the theories for the concentrations of trapped radicals that can be expected. These theories indicated some of the gaps in the knowledge of fundamental processes that need to be filled. The whole field of trapping radicals is reviewed by Dr. A. Thomas, with consideration of the properties required of radical-trapping solids. The methods for observing and studying trapped radicals are considered by Dr. R. W. Zwanzig. The methods discussed involve spectroscopy, electron spin resonance, magnetic susceptibility, mass spectrometry, calorimetry, X-ray and electron diffraction, dielectric constant and refractive index. The values and limitations of methods based on these measurements are considered, with emphasis on the spectroscopic and spin resonance methods, since these have proved the most versatile. The results of spectroscopic and spin resonance methods are also considered by Dr. O. Schnepp in his paper on the interactions between trapped species and the matrix. These interactions show up in various ways as modifications in the spectra observed as compared with the spectra for the gaseous species.

Finally the whole symposium is reviewed by Dr. M. W. Windsor. This last paper in the monograph covers the papers contributed from NBS as well as those contributed from other sources.

This monograph summarizes the state of knowledge concerning radical stabilization as it existed in September, 1959. The only minor criticism is that there is some duplication in the description of the work, which is probably inevitable in a publication of this type. Most of the papers include a full list of references and there is also a bibliography of publications from the NBS programme. To anyone interested in the field of radical stabilization or of low temperature chemistry it is an invaluable publication, and it will be of considerable interest to those interested in fundamental problems of the behaviour of low temperature solids.

J. G. WALLER

Ingot Yield Increased By 10 Per Cent

Continuous Casting of Steel. By M. C. BOICHENKO. *Butterworths.* (50*s*)

The Continuous Casting of Steel in Commercial Use. By K. P. KOROTKOV, H. P. MAYOROV, A. A. SKVORTSOV and A. D. AKIMENKO. *Pergamon Press.* (50*s*)

Continuous casting is one of the newer techniques available to the steel industry which, by raising the yield and uniformity of ingots, could increase the productivity of a given melting shop by an estimated 10 per cent if applied intelligently.

Despite this attractive possibility, the technology of continuous casting has developed extremely slowly; in fact it was first proposed by Bessemer, who has been credited with the first attempt to convert liquid metal directly into a semi-finished product. After a lapse of some fifty years during which technical knowledge improved, the process became more widespread and was an established technique in the non-ferrous industry in prewar years. Not until 1945 was the process investigated seriously in the steel industry, particularly in Germany.

Many technical papers published in the last ten years have shown that sufficient progress has now been made on the laboratory and pilot-plant scale to enable production units to be installed and, in fact, several units are now being built in the United Kingdom.

The two books now being reviewed show clearly that this state was reached some years ago in Russia. It is supposed that this lead is due not only to a concentrated research effort, but also to the fact that the cost of this research and the subsequent development would be borne by the iron and steel industry of the country.

Boichenko's book was published in Moscow in 1957 and is obviously the result of a number of years of research into both the history and the technology of the process as known at that time. As an introduction to continuous casting the book serves its purpose. The development and history of the process is reviewed in some detail as is the later work in the non-ferrous and steel industries. The greater part of the book is devoted to work done outside Russia, but some details are included of the research work at TsNIICherMet and a brief description of the Krasnoe Sormovo machine is included.

The second book, by Korotkov *et al.*, deals exclusively with Russian experience since the commissioning of this latter machine, mostly on the design and operating details of the machine itself. It is evident that much progress has been made in the period between the writing of the two books. The length of this period is disguised by the fact that both books were published in the United Kingdom at the end of 1960. It is obvious that Korotkov's book was published in some haste, which is a pity because the non-letterpress form is not easy to read and the photolithography used to reproduce the photographs obscures most of the detail. Otherwise the material is well presented and the importance of publishing technical data quickly, emphasised by comparing the books, more than compensates for these disadvantages.

This contention is verified by Boichenko who states in a foreword to his book: " The technique of continuous casting of metals is developing very rapidly and calls for periodic review."

While the books describe the art of continuous casting as it is known in Russia for large-scale operation, it will probably be understood that the process has a similar appeal for smaller quantities which can consequently be cast in smaller section sizes. In fact, pilot-plant operation in the Western world was confined for many years to small billet and slab sections, usually in alloy steels because the increased yield could realize a great saving in cost. Many workers have displayed considerable ingenuity in reducing the rate of temperature drop in small ladles, in regulating the pouring of alloy steels through small tundish nozzles, and in designing moulds and mould movements which enable higher casting speeds to be obtained.

The Russian workers quickly realized that while these factors are important in the particular field of high alloy steels, large slab sections could be cast at rates sufficient to make the continuous casting of bulk steels economically attractive. There is no doubt that a considerable amount of research and development work was required in order to build slab casting machines, and the book by Korotkov *et al.* describes, in a rather abbreviated fashion, some of the technical parameters which it is desirable to know in order to design a machine of optimum efficiency.

Incidentally, many mistakes are to be noted in this section of the book, as in Chapter 4, where, for instance, a drop in temperature apparently occurs in the water passing through the mould. It is regretted that many of the equations given are stated as fact, often following a somewhat tenuous assumption. Tables 3 and 4 in Chapter 4 contain a lot of gaps and this makes a true comparison of the efficiency of heat abstraction in the various zones difficult if not impossible. It is concluded from this and other evidence that while the Russian workers have made a lot of progress, there is still a long way to go before the optimum in plant design is achieved.

Nevertheless, each book is useful in its field: Boichenko will probably appeal most to the student and Korotkov to steelworks personnel who have to deal with the installation and working of continuous casting machines.

G. LITTLEWOOD

Agonising Readjustment to the Times

The Industrial Revolution in Coventry. By JOHN PREST. *Oxford University Press.* (21*s*)

In the 1820's Coventry's traditional ribbon-making industry was run by a dozen masters, who manufactured partly in their own factories, but also distributed silk to " first hand " journeymen, who wove it in their own homes on looms which belonged to them. The masters enjoyed a high standard of living, entertained in fine houses, kept good cellars, could afford to be generous with their weavers, and took pride in the established customs of their trade.

The first hand journeymen were *bourgeois* of some social standing. Many were freemen of the city. Custom allotted them two-thirds of the agreed " list price " for their products. This was periodically revised in amicable meetings between masters and men. There was no class war. A diligent journeyman could earn enough to save up to rent a modest house, own half a dozen looms, and enjoy his pint of best ale.

Below the first hand man came the ordinary journeyman, who fluctuated between working in a factory or for a first hand man. His ambition was to save enough to buy a loom and move up to become a respected first hand man.

The trade was disorganized by the boom during the Napoleonic wars, when many weavers were away in the army. The London wholesalers, disregarding their trade connexion with the established Coventry masters, discovered that they could get ribbons cheaper by making their own arrangements directly with the weavers. They threw the trade open to competition and anyone with a little credit could now enter it. The London merchants gave—five months credit for silk, and small masters emerged who were able to sell the finished product to the wholesale ribbon houses before their bills became due.

The dozen old masters now had to compete with 50 new small masters who, having little capital, lived from hand to mouth. They paid the weavers as little as they could. The old masters shared the weavers' desire for agreed prices, the traditional social structure, and a stable trade. They wanted Parliament to prescribe wage scales by law. For a variety of reasons, the traditionally minded majority of masters and weavers were able to maintain the old system, albeit with ever increasing difficulty, until 1860 when a great strike ended in ruin for all but a handful of masters and in the dispersal of the vast majority of weavers to work in expanding industries in other cities or to emigrate to America.

The majority of masters and men continued to observe the customs of their trade during these years, neither offering to pay, nor accepting, too low a wage. Unfortunately, says Mr. Prest, the few bad masters and bad men, having passed beyond the control of the majority, were always tending, as the natural result of competition, to bring the good majority down to their own level. Mr. Prest asserts that had the Government

listened to them, they would have been capable of governing the trade themselves, because the majority, prior to the emergence of competition, had always been able to agree on what constituted a "just price." But the Government, influenced by the doctrines of Adam Smith, thought that to regulate a trade would defraud consumers, and refused to co-operate with the ribbon masters and weavers to re-establish effective self-government.

Mr. Prest compares the situation in industry at any given time to Locke's "state of nature" in which human beings without government deteriorate into a state of war. "Men in industry are always striving to bring the state of nature to an end, but their attempts to do so must often be, and can always be represented to be, a brake on technical progress and a threat to the consumer. The difficulty in a democracy is to decide how high a price the community as a whole can afford to pay for the desirable object of letting masters and men in different trades govern themselves."

The author paints a harrowing picture of the suffering endured by the Coventry ribbon-makers in the forty odd years in which they were engaged in a stubborn rearguard action against competition. But he does not estimate the price that the community would have had to pay to enable the ribbon-makers to continue to enjoy their stable social and economic structure, not forgetting that once it was conceded that the ribbon-makers could decide their own standard of living, this privilege could not have been denied to every other industry.

Mr. Prest does not tell us how Coventry's agreed wage scales were related to the selling prices obtainable in the market. Is that not the basic point? If the ribbon-makers had had a world monopoly, or even a domestic monopoly enforced by a prohibitive tariff, they could have paid what wages the weavers wanted and charged what prices they liked to consumers. But who is to decide whether a price structure agreed between employers and workers is a reasonable one that the community can afford to pay? In a competitive market, if consumers consider the price of ribbons unreasonable, they cease to wear them. But if all manufactures were regulated in accordance with employers' and workers' ideas of fair prices, what would happen to the cost of living?

In fact, of course, something like this is happening to some extent in the United States and United Kingdom, where organized workers are strong enough to insist on annual wage increases, regardless of the community's interests. The result is (1) cost-push inflation and (2) an ever widening spread of the "do-it-yourself" habit among consumers in revolt. The worst hit are the professional classes, on whom economic progress depends. Their leisure, instead of being used for rest and recuperation, is increasingly spent in repairs, maintenance, the interior decoration of their homes, and so on.

Even the balance of payments comes into this situation. As *The Economist* said in reviewing Mr. W. Ashworth's *Economic History of England 1870-1939*, one cannot fail to be struck by the constant recurrence of concern about the balance of payments and export prospects in the 1880's, the 1890's, and in the interwar years. Is this merely periodic bad luck? Or does it indicate deep-seated and persistent habits, which impede Britain's performance? For the comparative failure of British exports before 1939 there were plausible explanations: for historical reasons Britain concentrated on exporting to primary producing markets types of exports, particularly textiles, for which world demand was expanding least rapidly. But since 1939 we have been moderately successful in tailoring our basic industries to meet the changes in the world economy. Yet our anxieties persist. Perhaps, suggested *The Economist*, the explanation lies in the social habits of an old and stable society, much less open and acquisitive than the American.

As a further edition of Mr. Prest's authoritative study is certain to be called for, it is to be hoped that he will elaborate his views on the questions that I have sketched in here. Mr. Prest is to be congratulated on a remarkable piece of painstaking research. He has not only meticulously sieved Coventry's archives but cleared up apparent discrepancies by putting on his hat and going out to explore the city's obscurer alleys and backyards. Too many economists seem to think that profundity of thought is a coefficient of the number of polysyllabic abstract words that they can work into sentences twisted, wherever possible, from the active into the passive voice. But Mr. Prest writes an agreeable straightforward prose. He has worked the personalities of the manufacturers, weavers, and factory inspectors, whom he has rescued from forgotten memoirs and contemporary newspapers, into a dramatic story, spilling over with human interest.

JOSSLEYN HENNESSY

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Plant and Equipment

Shears and Presses. JOSEPH RHODES AND SONS LTD., Wakefield, Yorkshire. Four brochures covering: Hydraversal Shears—describing the application, function and features of these multi-purpose shears; Fluid Drive Shears—giving a detailed account of design and operation, with advantages of economy and tables of effective length of cut; C-Frame Presses—describes a new series with important improvements; Stagger-Feed Press—for the high speed and efficient manufacture of light stampings. Ill. Respectively 6, 16, 20 and 6 pp.

Machinery Catalogue. BROWN AND TAWSE PLANT LIMITED, Ambrose Street, West Gorton, Manchester 12. Full information of general services is given, and a comprehensive description of products, including cranes, air compressors, saw benches, welding sets, pumps, electric hammer drills, pneumatic lamps, pneumatic tools, steam cleaners and diesel engines. 32 pp. ill.

Automatic Electroplating Plant. W. CANNING AND CO. LTD., Great Hampton Street, Birmingham 18. Describes the company's different types of automatic equipment and illustrates installations by manufacturers and trade platers covering a wide range of applications.

General Purpose Furnaces. WILD-BARFIELD ELECTRIC FURNACES LTD., Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Hertfordshire. Two folders, covering respectively vertical and horizontal furnaces, with general descriptions and specifications, dimensional drawings and details of atmosphere and temperature control. Uses are in hardening, carburizing, preheating, annealing and normalizing. Both 4 pp. ill.

Granulators. GOODWIN BARSBY AND CO. LTD., Leicester. Brochure detailing the range of Good-Win Acme roller bearing granulators, showing this crushing equipment as having been evolved to meet the increased need for well-shaped aggregate required for tarmacadam and roadstone. Strength of structure and economy of running are brought out, and a visual specification is given, with tables of capacities, dimensions and shipping details. 12 pp. ill.

Electric Furnaces for All Industries. METALECTRIC FURNACES LTD., Cornwall Road, Smethwick, Staffordshire. Bulletin No. M.1, which gives an accoun o f continuous, electric melting, heavy duty and controlled atmosphere furnaces. 8 pp. ill.

New Books

The Skills of Interviewing. By ELIZABETH SIDNEY and MARGARET BROWN. *Tavistock Publications.* (35*s*)

The authors aim to bridge the day-to-day needs and the practical experience of managers and administrators and the formal study of human behaviour. The result is a handbook that will reinforce—or possibly modify—the empirically acquired skills of persons with long experience in management.

Efficiency and Effort: An Analysis of Industria Administration. By W. BALDAMUS. *Tavistock Publications.* (18*s*)

The organization of industry ultimately revolves about a single process: the administrative process through which the employee's effort is controlled by the employer. Therefore, the entire system of industrial production can be viewed as a system of administrative controls which regulate quantity, quality and distribution of human effort.

The Business of Management. By ROGER FALK. *Penguin Books.* (3*s* 6*d*)

What makes a manager? Is modern management a science or an art? These and many other questions are examined by a leading business consultant who advocates that "rules" must be subordinated to wider, human issues. Enlightened leadership in management is a key factor in human survival.

The Manager and the Organization. By ERIC MOONMAN. *Tavistock Publications.* (21*s*)

An examination is made of the role of the manager within the organization in terms of coordination and communication. Practical guidance is given (based both on experimental and research work and on practice in industry) in the obtaining and communicating of information through reports, attitude surveys, interviews, discussion groups and joint consultation.

Decision, Order and Time in Human Affairs. By G. L. S. SHACKLE. *Cambridge University Press.* (35*s*)

The core of this work is the notion of decision as part of a continuing creative process—the introduction of a new strand in the emerging pattern of history. Professor Shackle analyses the relation of decision, so conceived, to probability, uncertainty and expedition and evolves a theoretical model for decision making.

Scientific Thinking and Scientific Writing. By MARTIN S. PETERSON. *Reinhold, New York; Chapman and Hall, London.* (56*s*)

The relationship of scientific logic to the writing of good expository prose is considered in terms of organization. The book is addressed in the main to students in the biological and physical sciences, but it does not presuppose extensive training.

Land, Water and Food. By HERBERT ADDISON. 2nd Edition. *Chapman and Hall.* (21*s*)

Commentary on the past, present and future of irrigation, land reclamation and the food supplies they yield. In this revised and enlarged edition, the story of land reclamation development has been brought up to date, and information included about the Aswan High Dam and irrigation developments in the USSR and China.

Engineering Drawing for Students. By RICHARD MARRIOTT. *Methuen.* (6*s*)

Intended for O-level students, the treatment is elementary, practical and brief. The various types of projection are explained, together with some basic geometrical constructions. Information is given on gears, cams, bearings, lubricating devices, keys and keyways, rivets, screws and bolts. There are drawing exercises in other machine parts, which are arranged in groups centred around specific machine types.

Engineering Drawing. By F. E. PAGE. Book 2. *Christophers.* (12*s* 6*d*)

This is for students who have completed a preliminary course in engineering drawing and are proceeding with the subject as required by the various technical courses and by the GCE O-level syllabus.

Mr. H. A. Heins, B.Sc., is a Circuit Design Engineer in the laboratories at Mullard Southampton Works.

Dr. J. G. Waller, B.Sc., A.R.I.C.A., A.R.C.S., worked for six months on the NBS free radical programme. He now holds the position of senior scientist in the Scientific Division of the British Oxygen Company. He is a member of the Chemical Society and Society of Chemical Industry.

Mr. G. Littlewood, A.I.M., is head of the continuous casting and ingot section in the British Iron and Steel Research Association.

Mr. Jossleyn Hennessy, M.A., is an economist, broadcast commentator and London editor of the *Eastern Economist*, New Delhi. He is the author of several books, including *The European Common Market: What Will it Mean to You?*

Marketing

Australian Navy Order Westland Helicopters

AGAINST lively United States competition, WESTLAND AIRCRAFT have obtained a £6 million order from the Australian Government for 27 Wessex anti-submarine helicopters, with their spares. The helicopters will be used by the Royal Australian Navy.

Westland's successful sales efforts had to overcome the powerful effect created by the decision of the Royal Australian Air Force to order eight BELL Iroquois. In line with the desire of the Australian Government to standardize the Service's helicopter facilities on one model the Royal Australian Navy was in favour of the Iroquois.

With the difficulties apparently multiplying against them the Westland deputy managing director and a senior design engineer went out to Canberra to back up their chief sales engineer on the spot. The three were able to put over to the Navy the anti-submarine advantages of the Wessex. Discussions went on with the Ministers concerned and were resumed in Britain when the Australian Minister of Defence, Mr. Athol Townley visited this country.

Evaluating the Iroquois, the KAMAN Seasprite, and Westland's Wessex, the Australian Government finally came down in favour of the Wessex for the Navy's needs. The helicopters will go into service on board the RAN carrier Melbourne and will be the leading anti-submarine weapon for the Australian naval forces. The first Wessex for this contract is due to come off the production line in 1962, completion of orders is planned for mid-1963. Aircraft are to be delivered direct to the Melbourne when she visits England.

Two European States Adopt Bloodhound II

Switzerland and Sweden are to use the Bristol Ferranti Bloodhound Mark II surface-to-air guided missile system in their air defences.

The Swiss decision to use the Bloodhound Mark II, which has an advanced form of the Bristol Siddeley Thor power unit involves a contract worth between £25 and £30 million.

Bristol Siddeley Thor ramjets powered the Bloodhound Mark I missile which is in service with the Royal Air Force and is on order by Sweden and Australia. Bristol Siddeley are the only company outside the United States who have a large ramjet in quantity production.

Still closely akin to the earlier Bloodhound, the Mark II has better range, better operational flexibility and greater effectiveness. The outstanding development incorporated has been the continuous-wave radar guidance. In addition to enabling the range to be extended, continuous-wave guidance means that greater effectiveness is obtained against all types of target down to low altitudes and against sophisticated electronic counter-measures.

The BRISTOL AIRCRAFT Company are a part of the BRITISH AIRCRAFT Corporation, who have drawn attention to the strength of the industrial consortium behind the design, development and manufacture of Bloodhound. The concerns involved, in addition to the Bristol Aircraft Company, acting as weapon system managers, are FERRANTI, ASSOCIATED ELECTRICAL INDUSTRIES, and BRISTOL SIDDELEY ENGINES.

Agricultural Engineering Exports Improving

British agricultural engineering exports in the first five months of the year improved by 5 per cent over the equivalent period of 1960.

Figures given by the AGRICULTURAL ENGINEERS ASSOCIATION show that in May there was an appreciable advance in exports of agricultural tractors and spare parts.

Agricultural implements, which in the first four months had shown an 8 per cent rise on last year, maintained the better showing. Combine harvesters, which have fallen back in sales, have made a slight recovery. Up to the end of May combine sales were 59 per cent of the equivalent period in 1960, against 56 per cent up to the end of April.

The AEA has been drawing some interesting comparisons with our main competitor, West Germany. Over the first quarter of this year British agricultural engineering sales overseas were going ahead faster than those from Germany.

In the expanding Swiss market United Kingdom exporters have gained an increased share; British sales in France have been growing faster than those of the Federal Republic and UK exports are doing better in Finland while those from Germany have been falling.

Belgium, Italy and Portugal all bought larger numbers of West German tractors but UK shipments have improved while German have declined to Austria, Norway and Greece.

Attwood Appoint Economic Research Chief

The first appointment of ATTWOOD TECHNICAL SERVICES LIMITED, a new UK company which is to undertake economic research on a world-wide basis, is that of Mr. D. H. McNeile, who becomes chief executive.

For the past two years Mr. McNeile has served with the UNITED KINGDOM ATOMIC ENERGY AUTHORITY, for the last twelve months in the commercial branch. He was before that for eight years with the IRAQ PETROLEUM Company, including a year as secretary to the management committee.

Consultants in Retailing

The use of management consultants is rarer in retailing than in manufacturing industry. This might be because retailers tend to be smaller units—small units of any kind are less likely to bring in consultants—or it might be because they are too busy to consider the niceties of management. Whatever the reason, it is obvious to the mere customer that most shops would profit from improvements in, for example, layout and stock presentation.

People like the British Productivity Council have been saying this for some time, and now the Management Consultants Association has published a "blue book" showing how consultants can help retailers. This booklet breaks down the retailing function into four primary considerations, namely, (*a*) buying the right merchandise in the right quantities at the right margins; (*b*) the number of prospective customers who can be attracted into the shop; (*c*) the degree of profitable utilization of the total floor area; (*d*) the effectiveness of clerical procedures in dealing with the financial aspects of the business.

Management consultants, the booklet explains, can help retailers in these four fields by studying purchasing policy, research into market potentials, shop layout, display, staff training, the scope for work study and accounting procedures. In the last category are included cost control, credit control, stock control, budgetary control, forecasting and general control information for management.

Some retailers are already aware of the importance of these fields and have had studies made of them, but it seems clear that there is much scope for management consultancy in this final stage in the marketing of consumer goods. Economies must be effected in distribution as well as in manufacture.

British Building Materials Go to North America

Production agreements have been made with firms in the United States and Canada that will enable two British products, Metolux cold casting metal filler and Terrazzite industrial and decorative flooring, to be made there in quantity. Mr. Charles F. Jenvey, chairman and managing director of PLASTICS AND RESINS Limited of Bilston obtained the agreements during a three week tour of the North American continent.

Negotiations are in progress between TEXSTAR CONSTRUCTION CORPORATION Limited in San Antonio, Texas, and Plastics and Resins about the formation of a new joint company in Texas. In Canada, the company have set up their own subsidiary.

The Texstar Corporation have already established a self-contained Terrazzite division and they are to invest $500,000 (£170,000) in a new production building and equipment to make tiles and curtain wall units under the agreement—these are two developments not, as yet, available in Britain.

Texstar are also appointing a network of 26 contractors in the United States who will be able to produce and lay *in situ* Terrazzite flooring.

The material is already being specified by American architects though it is only a short time since it was introduced there.

"In Canada," reports Mr. Jenvey, "our present system of selling Metolux is doing so well—despite the extremely high costs due to taxes and transport charges—that we are to establish our production and sales organization in Ontario."

Kaiser-Ilin Plant Opens in Israel

BARCLAYS BANK DCO report the opening in Ashkelon, Israel, of the KAISER-ILIN plant manufacturing machine tools, motorcar spare parts and gears. The works was built in two years and cost I£7 million. When full production is reached in two years there will be employment for about 1,000 workers.

Seventy per cent of the investment came from Israeli Government loans.

Second Computer for Dutch University

The TECHNISCHE HOGESCHOOL, of Eindhoven, Holland, has bought its second analogue computing system. The system is a PACE analogue equipment, produced by ELECTRONIC ASSOCIATES INCORPORATED (EAI) of Long Branch, New Jersey, USA.

This £18,500 computer has 40 operational amplifiers, electronic digital voltmeter, 100 hand-set potentiometers and a selected complement of non-linear elements. It is to be installed at the Afdeling der Werktuigbouwkunde. The same university has on order another PACE system to be installed at the Afdeling der Algemene Wetenschappen.

The PACE machine going to the Werktuigbouwkunde is the seventh of EAI's manufacturers's large computers to be sold in Holland in the last four years and the fortieth in Europe.

Electronic Associates Incorporated, through their EAI European Continental Marketing department in Brussels, has sold its second large computing system in Switzerland. This is an expanded PACE 231R computer, bought by the SWISS FEDERAL INSTITUTE OF TECHNOLOGY.

The system will be installed at the Institute of General Electric Engineering and Automatic Control. It has more than 100 operational amplifiers, 150 hand-set potentiometers, electronic digital voltmeter and is also equipped with the recent high speed repetitive operational development. It will be the first computer on the Continent making use of this display.

A New Industry for the North East

DURHAM COUNTY COUNCIL planning committee are this month to consider the establishment of a new town at Washington, near Sunderland. The prospects of attracting a sufficient number of companies appear relatively fair for it has been confirmed that negotiations have been going on for the setting up of a TUBE INVESTMENTS factory at Washington.

The chairman of the Washington Urban District Council has said that the new project is understood to be for a rolling mill. An eventual labour force of 6,000 people has been suggested.

Creating a new town at Washington, with a 66,000 population and 300 acres set aside for industrial development, would cost some £50 million.

Japanese Expansion by Dunlop

DUNLOP JAPAN are to carry out further extensive expansion of their Kobe and Nagoya factories. £5 million is to be spent on providing new buildings and plant and modernizing existing equipment over the next two years.

The company's share capital is to be increased from £1,750,000 to £3,000,000. Other financing of the new capacity will come from the company's own resources and from bank credits. Japanese participation is to increase from 29 per cent to 50 per cent, in which SUMITOMO ELECTRICAL will hold 40 per cent and the LONG-TERM CREDIT BANK 10 per cent.

The Cossor Model 1049 Portable Double Beam Oscilloscope

No specialist knowledge of electronics is needed to use the oscilloscope designed with the mechanical engineer in mind.

THE Cossor Model 1049 Double Beam Oscilloscope shows that electronic principles can be of use to the engineering designer or stressman. It is an instrument designed specifically to assist him in the study of the behaviour of a physical system.

An oscilloscope can be used to display on its screen by means of a travelling pinpoint of light or "spot," the graphical presentation of the variation of some physical phenomena as a function of time, provided that such variation can be converted into an electrical signal. The Model 1049 was designed specifically for this application and is used extensively in all branches of industry. It operates in conjunction with a transducer—a term which covers a whole range of devices used to convert the variations of the phenomena being studied into an electrical signal.

The information is displayed as a two-dimensional record by means of an electronic beam generated in a cathode ray tube. The advantages of a cathode ray tube for portraying such information are well known but will bear repetition in this Product Profile. It is the qualitative information provided by the instantaneous two-dimensional recording facility that is so useful.

Quantitative results may also be obtained with equal success so long as the essential precautions and calibrating arrangements are followed; and in this respect the instrument is only superior to other kinds of device in providing a much greater consistency in the results obtained. The reason is that for constant tube HT voltage the readings are only dependent upon the geometry of the tube, which is of course constant; and they are not affected during the tube life by such factors as (say) wear of moving parts.

THE CATHODE RAY TUBE

The cathode ray tube appeared in its first form at the end of the last century and the experiments which led to it date back nearly 100 years. The first tubes used for recording purposes were manufactured on the Continent in 1897 and the Cossor company produced them in this country in 1902; before the development of the thermionic valve.

Little serious work was undertaken in the application of the cathode ray tube, mainly due to its very high operating voltage; but with the development of the low voltage sealed-off tube in the early 1920's it was possible to make a portable cathode ray oscilloscope. The development of this tube in conjunction with the thermionic valve, in which Cossor played an important part, gave rise to the first commercial oscilloscope in 1932. Incidentally, until recent years Cossor oscilloscopes were always known as "oscillographs."

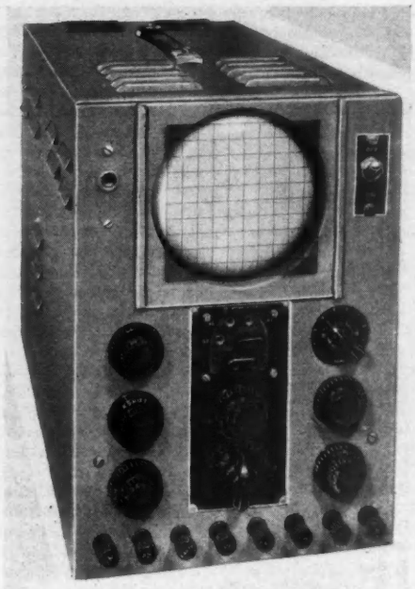


Fig. 1 The first commercial double beam oscilloscope, the Model 339.

THE DOUBLE BEAM INSTRUMENT

It was soon realized that the usefulness of the single beam instrument would be enhanced if two complementary effects could be studied at the same time, and many problems could be solved more easily with this facility. A modification of the tube devised by Fleming-Williams in 1938 produced two traces from a single electron gun by a process known as beam splitting. In this way two signals could be displayed on the screen at the same time. Tubes of this type have formed the basis of the long line of Cossor double beam oscilloscopes.

At this time there was no delay in obtaining suitable valves to drive the tube. The introduction of television on a commercial scale in 1936 led Cossor into designing valves specifically for the transmission and reception of television signals of much higher frequencies than were encountered in normal radio. These valves gave a remarkably high amplification and were the forerunners of the high "slope" valves in use today. It was the obvious combination of these valves with the split beam tube which formed the basis of the first double beam oscilloscope. It was known as the Model 339 and was first used for the testing of television transmitters and receivers and for the maintenance work required for this new medium. The 339 appears in Fig. 1.

The start of hostilities in 1939 led to tremendous increases in the development of radar equipment which was not only secret but, at that time, had no specific name. The oscilloscope was the only means by which the performance of the electronic circuits could be ascertained. The 339 became the standard oscilloscope for all the Allied forces, including the Americans, in the Second World War. It is some indication of the success of the instrument that the comprehensive instruction manual containing a quantity of basic information on the then comparatively new art of oscillography has had to be reprinted many times, and still finds an eager demand from newcomers to the subject.

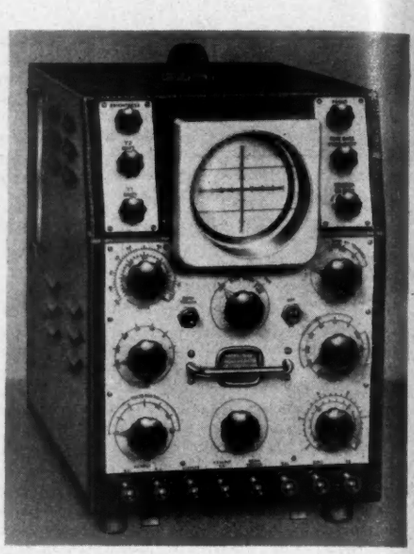


Fig. 2 One of the earlier marks of the Model 1049 which preceded the Mark IV.

After the war the personnel who had been using the cathode ray oscillograph began to apply it to their peacetime business and the demand grew rapidly. 1947 saw the introduction of a more refined version intended for use by electronic engineers, the Model 1035, and it was followed a year later by the Model 1049 designed specifically for the engineering industry. Cossor had thus replaced the versatile 339 by two instruments selling in parallel, each aimed at a particular section of the market. From this first appearance in 1948 the Model 1049 had been in continual demand and the various refinements introduced during that time have resulted in the Mk. IV version. This oscilloscope is one of few such instruments on the market whose detailed design is based upon so many years of actual experience in the field.

SOLVING PHYSICAL PROBLEMS

An electronic device like the cathode ray oscilloscope will not necessarily suggest itself as an aid to solving physical problems. Mechanical engineers often tend, not unnaturally, to be suspicious of electronics. It was the aircraft industry, with its exacting design requirements, that started to use the instrument in quantity, thus proving the reliability and accuracy of electronic measuring devices. There are many uses which this industry found for the cathode ray oscilloscope, such as the measuring and analysis of vibration, fluctuation in pressure, or deflection and displacement; in fact, general

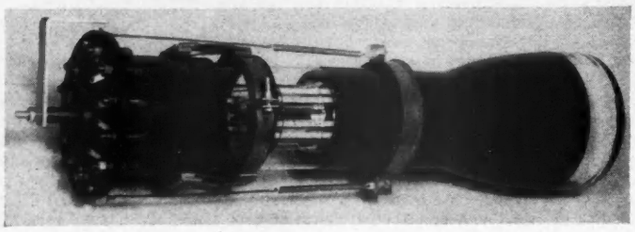


Fig. 3 (left) Cathode ray tube for the Model 1049 Mark IV.

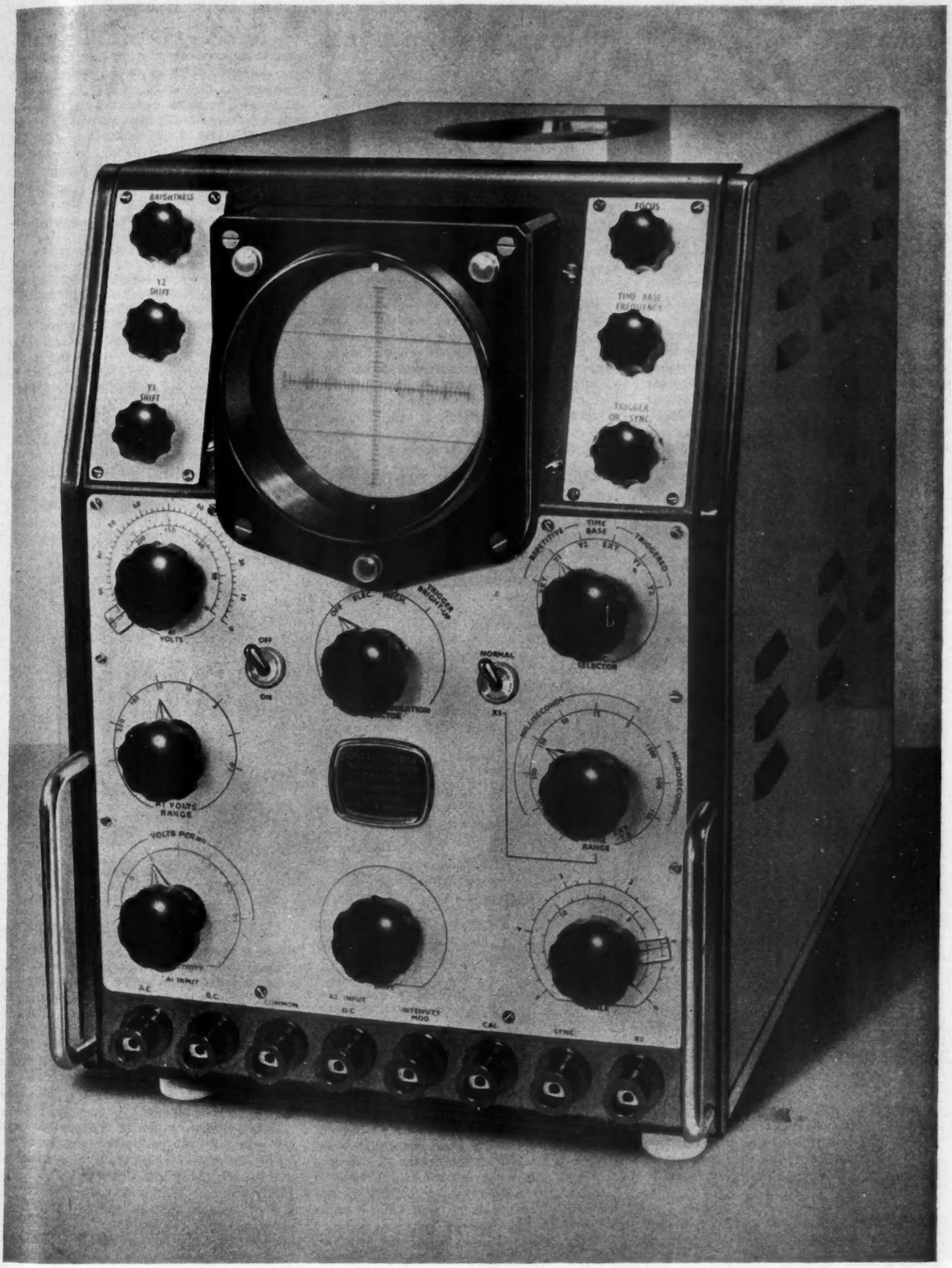


Fig. 4 Where a more specialized instrument has succeeded in creating a broader market.

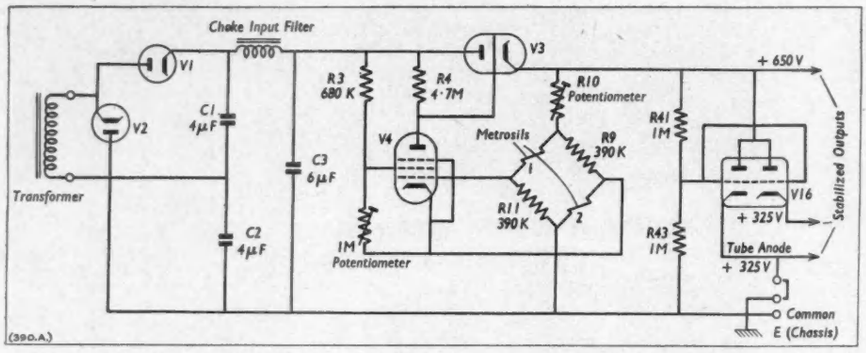


Fig. 5 Simplified HT circuit which incorporates a Metrosil bridge stabilizer.

analysis of the dynamic forces and resulting stresses encountered in mechanical structures.

Due to the low inertia of the recording medium, the device is extremely useful for measuring shock load or instantaneous forces which cannot be recorded in any other way. A simple application for the study of vibration to indicate mechanical "soundness" is the familiar wheel-tapping test used by railwaymen. This procedure has been applied with the aid of an oscilloscope to test electrically the frequency and decrement of the vibration of grinding wheels and of the front forks of bicycles before assembly (Fig. 7).

A tapping hammer is arranged to give an impact of constant amplitude, and the frequency and duration of the ringing note produced in the forks is recorded automatically on the oscilloscope screen. The controls are deliberately masked since the reliability and stability of the instrument makes it unnecessary for adjustments to be made on work of a purely repetitive nature. The operator need have no knowledge of electronics; to her the use of the oscilloscope is a routine operation giving a positive indication of the metallic structure of the fork.

Recent developments in double beam oscilloscopes have been made in three directions:

(1) to provide greater sensitivity,
(2) to cover a wider band of frequencies for the vertical signal, and
(3) to measure smaller and smaller intervals of time.

Though well beyond the requirements of a mechanical engineer the oscilloscope of today is capable of measuring time in fractions of a millimicrosecond—the time taken for light to travel a distance of one foot.

There are other ways of obtaining two traces on an oscilloscope besides the split beam. One method employs two cathode ray tubes in one glass envelope, called the "two-gun" tube. Another method uses an electronic means for switching the two input signals alternately to the vertical deflection system of the oscilloscope. Cossor use all three methods in their complete range of instruments and choose whichever is technically most suited to the application.

INCREASING COMPETITION

Factors governing the sale of oscilloscopes have radically changed over the past 20 years. Other firms have come into the market as the original Cossor patents expired and the manufacture of oscilloscopes is an increasingly competitive business. For this reason the research and development experience which the company has gained over so many years is now being used to produce both the simple oscilloscope required for routine measurement and the precision instruments which rank among the high performers commercially obtainable. In addition to their research and development division the company has for many years employed a technical advice bureau able to advise the prospective customer on the solution of his particular problem.

To increase the range of application of the cathode ray oscilloscope many accessories have been designed, which no doubt play their part in the instrument's success. They include such items as a pressure transducer and wheeled trolley; but undoubtedly the most important is the recording camera. The original Cossor cameras appeared on the market in 1934 and thus the continuous development has laid down a standard for the photographing of oscilloscope traces which has been followed by the majority of manufacturers in this country.

CAMERA USES

A camera can be used in a number of ways. It can produce photographs of the traces displayed on the cathode ray screen for record purposes or for reproduction in reports, or it may serve as an integral means of obtaining the recording which is desired. It is used in this way when the effects of a single event, an explosion for instance, have to be recorded in a small interval of time for study in detail later. Alternatively a motor drive unit can be fitted to the camera and used to move the film past the recording aperture at a constant speed. In this way the vertical movement of the recording spot is used to trace a line on the moving film. With the latest camera, written information may also be recorded on the film for ease of identification at a later date.

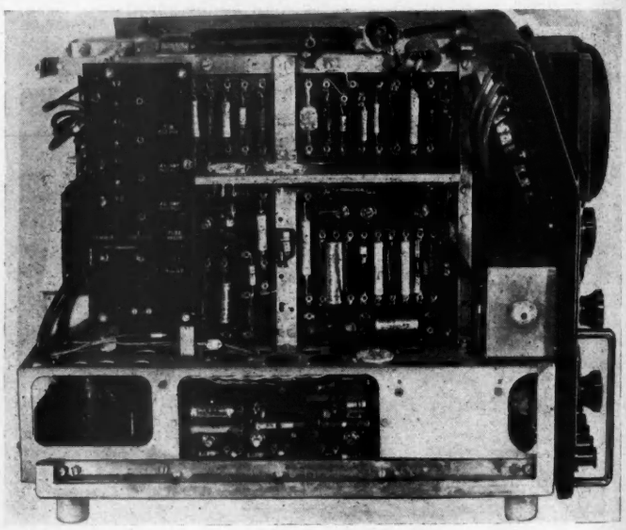


Fig. 6 (right) Left hand internal view.

Fig. 7 (left) The Model 1049 being used for repetitive testing of bicycle forks.

The Cossor organization now consists of a group of substantially autonomous companies. Cossor Instruments Limited has a staff of about 200, devoted entirely to the design and manufacture of electronic instruments. The group's origin goes back nearly 70 years to Mr. A. C. Cossor's small workshop in Clerkenwell where scientific glassware was manufactured. In 1908 a limited company was formed and in 1916 came the first cathode ray oscilloscope.

Cossor's success in double beam oscilloscopes has radically changed the conception of the instrument from a laboratory tool to an industrial measuring instrument. About 15,000 Model 1049's have been sold in the last ten years, over half of them in markets spread all over the world. Despite the instrument's long life and inherent reliability there appears little likelihood of saturation being reached in the foreseeable future.

Cossor Instruments Limited, Highbury Grove, London N5.

Progress in Steel-Casting Research

Experimental work on the reversed slag process of steelmaking, working on both magnesite and dolomite hearths, has been completed at the British Steel Castings Research Association. The results of this research are given in the current annual report of the Association.

The rate of sulphur removal can be increased, especially at low sulphur levels, by agitating the bath, by the injection of nitrogen well below the slag/metal surface and by dispensing suitable powdered materials in the nitrogen stream.

When working on a magnesite hearth, it is possible to produce steel with a low sulphur and low hydrogen content by a reversed, two slag process—that is a reducing period followed by an oxidizing period. With a dolomite hearth, this has not been found possible due to sulphur reversion from the hearth during oxidation.

Works trials have been carried out in a five ton arc furnace with a dolomite hearth. As a result of these trials it has been found that the injection of calcium carbide alone was not effective in promoting rapid desulphurization and that to do this required more complex powder mixes, such as calcium carbide/magnesium/fluorspar or burnt lime/magnesium/fluorspar. When using such mixes, rapid desulphurization to low sulphur levels has been obtained.

As in the experimental work, it has not been possible in these trials to obtain very low sulphur levels by the application of the reversed two slag procedure because of sulphur reversion from the hearth. However, it has been possible to obtain steel of a low hydrogen content (about 2 ml per 100 g) with sulphur contents of less than 0·02 per cent by such a process.

A radiographic technique is now being used at the Association's laboratory to measure the severity of pinholing, and steelmaking variables are now being investigated.

It has been found that additions of strong deoxidizers, such as aluminium, titanium and zirconium, drastically reduce the severity of pinholing and that zirconium is the most effective.

So far, no relationship has been found between the severity of pinholing and atmospheric humidity. The effects of bismuth and selenium additions have also been studied, but neither of them were effective in eliminating pinholes.

Test castings have been made in carbon-free iron and the number of pinholes was thereby noticeably reduced from about 100 to 300 (obtained with steel made to British Standard 1617, grade A) down to about 10 to 20. These experiments, together with the work on deoxidants, offer further substance to the belief that the carbon oxygen reaction is of prime importance in pinholing.

Microscopic and radiographic examination of mould pour out castings showed that the growth of the pinholes is preceded by the formation of fine capillary tubes at the mould/metal interface, which apparently acts as a nuclei for the pinholes.

Methods of artificially increasing the hydrogen and nitrogen content of the steel have been developed. Work is proceeding to study the effect of these on the severity of pinholing, both in the presence and absence of carbon. A start has also been made on a study of the effect of the moulding material variables on pinholing.

Radio Station Concentrates on Space

Satellite tracking facilities which were recently opened at Winkfield, Berkshire, are now being operated in association with the US National Aeronautics and Space Administration. The Winkfield unit, which is an outpost of the Radio Research Station has been described as "a valuable asset to space research at the Station (RRS) and to the national effort in this field."

Preparations are now in hand to collaborate with Canada and the USA in conducting investigations on the ionosphere by using satellites; these will be known as the "top side" experiments because they will facilitate measurements on the remote side of ionospheric layers.

An experiment has also been initiated to make use of a rocket-borne apparatus in exploring the radio wave field above a low-frequency transmitter on the ground; thus obtaining information about the lower region of the ionosphere.

The current annual report of the Radio Research Station indicates that the work of the station is being re-oriented toward further space research. In fact, about 50 per cent of their effort will soon be devoted to this work.

The emphasis of the new work is on the study of fundamental geophysical problems by using newly available space-vehicle techniques.

All aspects of the research programme demand accurate measurement of radio phenomena and it is a continuing policy of the Station to conduct research on various measurement techniques.

During the past year, signals have been received from a number of satellites on various frequencies and measurements made on Doppler frequency shift, Faraday fading and signal strength scintillations. These data have been used in studies of the ionosphere.

British observers interested in cosmic ray intensities and the balance of incoming and outgoing radiation to and from the earth have received the results of analysed recordings from Explorer II.

Predictions of the positions of all satellites of interest to observers in the United Kingdom have been regularly issued. The observations required for predictions have increased, particularly with the launching of larger satellites such as the communication balloon-satellite, Echo.

As a result of the knowledge of the ionosphere that has been built up at the Radio Research Station over the years, a "once for all" book referring to world-wide condition in those parts of the ionosphere which sustain long-distance communications is being prepared.

Further work has been carried out on the application of the back-scatter sounding technique to the planning of communication services.

Complex Seas Simulated in New Model Basin

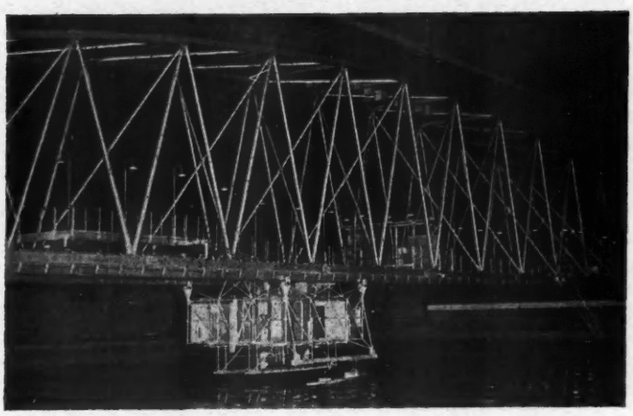
The largest simulated ocean in the world was recently put into operation by the US Navy at the David Taylor Model Basin. The huge new building covers five acres and houses not only the "ocean" but also a rotating arm basin of 260 ft diameter.

The availability of these facilities marks a major advance in the US Navy's ability to predict full-scale performance of waterborne vehicles in realistic seas and to solve complex problems of their stability and control. These model basins, first the Experimental Model Basin and more recently the David Taylor Model Basin, have been predicting performance of ships for more than sixty years by means of model tests. These predictions have been somewhat idealized in that tests could be made only in smooth water and in "regular" waves encountered only infrequently in the oceans.

The two new research facilities will afford the opportunity to run tests in variable and confused seas which more nearly resemble the actual ocean conditions and at any angle to the waves. Furthermore, it will be possible to execute many manoeuvres to test the handling qualities of the ship which formerly could not be run in the confines of the existing facilities.

Ships of the future will be designed for much higher speeds than existing ones. Therefore, means must be found to enable these ships to meet and ride out the roughest seas without severe damage to ship or cargo, to execute all kinds of evasive manoeuvres or to serve as a stable platform for launching guided missiles or aircraft. The intricate problems in hydrodynamics arising from these requirements can be studied more extensively and thoroughly in the new facilities. Furthermore, the relationship between tests and real oceanic conditions will be much closer than ever before.

The research facilities of the US Navy's model basins are made available to the American maritime industry by Congressional ruling. In the past the model basin has not been able to meet all the requests from private industry but, with the operation of the new facilities, it is expected that much more time will be made available in the future to shipbuilders and naval architects.



A 16 ft model of a high-speed ship traverses irregular long crested waves in the new manoeuvring and sea-keeping facility.

Several Ways for Better Gas Production

The pattern of town gas production in the United Kingdom has changed considerably during the last ten or twelve years, and is likely to change even more in the near future.

PRIOR to the nationalization of the gas industry under the Gas Act of 1948, the picture over most of the country was one of a large number of relatively small gasworks, each with its own separate distribution network. The great bulk of the gas produced was manufactured from coal by the conventional carbonising process, adjustment of the gas characteristics to the declared calorific value being by means of diluent gases, such as blue water gas or producer gas, made from coke resulting from the carbonising process. For peak load purposes reliance was placed on the production of carburetted water gas.

National Grid

The years since nationalization have seen a progressive integration of the gas undertakings within the territories of the Area Gas Boards. Well over 600 of the smaller and less economic works have been closed down, production being increased and concentrated at the larger works, and the distribution networks being linked by trunk mains for bulk transmission. The result is that a number of Area Boards now supply gas to the whole of their territory by way of a single trunk main into which all the gas production centres feed; other boards are progressing towards this state of affairs, and already have a small number of large integrated distribution networks, although, for geographical and other reasons, there are still quite a number of isolated gasworks with their own distinct distribution system.

It is clear that the logical outcome of this process of integration should ultimately be to extend it to form an interlinked distribution system covering the whole country based on bulk gas production with transmission of gas. This concept depends on the production of gas in large units considerably more cheaply than it can be produced locally.

The principal objective of a national grid system would be to supply gas which would be non-toxic and free from sulphur at a cost lower than that of gas made and distributed under present conditions. This can only be economically feasible if the gas is made in a small number of large gas making units situated at the source of the raw materials used for production. The industry is likely to look to coal as a raw material for base load gas, and oil, oil products and methane both for reforming to town gas for peak load purposes and for enrichment of the base load gas.

It is visualised, therefore, that coal gasification plants would be situated close to the pithead, while plant for production of gas from oil and oil products would be sited in coastal areas near refineries to provide a degree of operational and economic flexibility within the Boards in whose areas they were erected, and also, when required, to augment supplies to the national grid. Imported liquid methane would be delivered as methane gas to the Area Gas Boards.

Research Report

on work being carried out by the gas industry in the United Kingdom

Report by

D. SCOTT WILSON, M.B.E., Assistant to the Scientific Adviser to the Gas Council,
Murdoch House,
1 Grosvenor Place,
London W1.

Gas from Coal

The conventional type of carbonising plant has been brought to a high pitch of thermal efficiency. This thermal efficiency can only be maintained if adequate supplies of caking coal with a high volatile content are available, and the economics of the process are dependent on a satisfactory market for the coke produced. The shortage of the right type of coal and severe competition in the coke market has led the industry to seek for alternative processes which will operate on weakly-caking or non-caking coals, especially those of inferior grades. Such processes would be processes for complete gasification of the coal without production of coke. It would also obviously be an advantage if such processes could produce gas at high pressures, of the order of 20-30 atmospheres, since this would lessen considerably the cost of transmission in the trunk mains of a national gas grid.

One such process, the Lurgi process, was developed in Germany to gasify brown coal with steam and oxygen at 20 atmospheres pressure. Dr. F. J. Dent[1], Director of the Gas Council's Midlands Research Station, has demonstrated that the process can operate successfully on a range of British coals of low rank. Within the last few months the first full scale Lurgi plant in this country has gone to work.

The plant is situated at Westfield, in Scotland, and the first stage, which has now been completed, is producing 15 million cu. ft of gas per day. A second stage, due to be completed shortly, will raise this output to 30 million cu. ft per day, which will be equivalent to one fifth of the total gas sold in Scotland at present. Enrichment of the Lurgi gas to town gas calorific value is done by addition of butane. A high pressure pipeline is under construction across the centre of Scotland which will be linked in with the existing Scottish grid system. Already some 75 miles linking Coatbridge and Newport to Westfield have been laid. Gas is available from Westfield at a pressure of 250 lb per sq. in, the highest pressure ever used in the United Kingdom for distribution of town gas on the large scale.

The Gas Council, however, has taken the view that no one single process for gas production can be selected as the best from a number of competitors. It has therefore undertaken an extensive programme of research into a number of different methods of gas production which can be combined into a gas-making system in various ways to suit particular requirements.

One of the drawbacks of the standard Lurgi process has been its high steam consumption and low efficiency of decomposition of steam, resulting in the production of large amounts of aqueous effluent. Recent developments show some improvement in steam consumption and a modified form of the process[2] is being studied at the Council's Midlands Research Station in which the process is operated at a high temperature with withdrawal of the ash as a slag. This increases the efficiency of the process, saves steam and also makes the process more flexible with regard to coal size.

It may be desirable in some circumstances to produce gas from coal at ordinary pressures and to dispense with the use of oxygen. The Rummel twin-shaft gasifier[3] in which small, high ash coal is injected with steam on the surface of molten slag is being studied on the pilot scale at the London Research Station.

All these processes produce hydrogen-rich gases which require enrichment to town gas quality. A process is also under investigation whereby rich gas is produced directly. This is a two-stage process for the hydrogenation of coal[4] the first stage bringing the coal into the right physical state for the second stage and producing valuable aromatic by-products of high quality. The main hydrogenation stage following this produces gas of town gas quality, or of higher calorific value if required. The "char" remaining from this stage could be used to produce the hydrogen required for the two hydrogenation stages. A process for gasification of this char with oxygen and steam in a fluidised bed is therefore under investigation.

Gas from Oil Products

The gas industry has long used water gas as a diluent for rich coal gases. This is made in plant capable of being rapidly started up from cold and as rapidly shut down. This feature makes the water gas process eminently suitable for meeting peak loads. In the conventional types of plant blue water gas is produced from steam and coke and then enriched by carburetting with gas oil to produce enriching hydrocarbons in the gas. More recently[5] plants have been adapted to use light distillates for carburetting and for obtaining a 20 per cent increase of output by a process of reforming in the fuel bed.

Recent years have seen the installation of two processes on the commercial scale for the direct production of town gas by the catalytic gasification of oils with steam. Fuel oil, gas oil or light distillate can be gasified using a nickel catalyst in the Onia-Gegi process, or using a lime-magnesia catalyst in the Segas process.[7, 8] this latter process being designed and developed by the South Eastern Gas Board. Tail gases from oil refineries can also be converted catalytically to town gas, and several plants are now in operation.[9]

These cyclic processes suffer from the inherent disadvantages of restriction on productive time, over-design of plant to accommodate the difference in the instantaneous and overall rates of production, and greater complexity. Furthermore they operate at near atmospheric pressures. Hydrogen-rich gas can, however, be produced with a carbon monoxide content below 4 per cent and virtually sulphur-free by the high pressure gasification of petroleum products with oxygen and steam to produce water gas, followed by sulphur removal, shift conversion of carbon monoxide, and removal of the carbon dioxide thus formed.

The first large installation by the gas industry in this country of such a process, the Shell gasification process[10] is being installed at the Isle of Grain adjacent to the Kent refinery of the British Petroleum Company Limited. The town gas leaving the works will be a mixture of four components in the finished installation—hydrogen-rich gas, oil gas from Segas plants, refinery gas and nitrogen—which will be blended to give a final mixture at 500 Btu per cu. ft and 0·51 specific gravity.

As with the work on coal gasification, an extensive programme of research is being undertaken into new methods of gas production from petroleum products. These include production of town gas or rich gas by the high pressure hydrogenation of oil, with or without production of liquid aromatic by-products,[11, 12] the production of town gas by catalytic gasification of light distillates at high pressure,[13] and the manufacture of hydrogen-rich gas by reforming rich gas produced, by example, by the oil hydrogenation process.

Other Sources

The uses of other sources of gas are also being actively explored. Although the search for natural gas in the United Kingdom has so far failed to yield large results, use is already being made of small amounts from deposits at Cousland in Scotland and at Whitby in Yorkshire. Exhaus-

tive trials of the importation by ship of liquid methane[14] from America have demonstrated the technical feasibility of the project, and now its economics are being studied. The possibility of importation of liquid methane from the Sahara has been examined, and at the time of writing a scheme for its importation from Algeria is under consideration by the Minister of Power.

Combustion Characteristics

From what has been said above it will be clear that the gas industry is already concerned with gases differing widely in type from conventional town gas, and will be faced in the future with an even wider variety.

Purchasers of approved gas appliances expect that such appliances, correctly installed, will give an efficient, satisfactory and safe performance. This can only be achieved if a gas is supplied that ensures complete combustion, gives the correct heat input and shows no tendency for the flames to lift off the burner, to light back or to deposit soot or to burn noisily. The properties of fuel gases that govern these effects are spoken of as the combustion characteristics of the gas.

The three most important characteristics are the calorific value, the specific gravity and the flame speed of the gas. The first two give the heat input to an appliance, and can be combined in a single factor, the Wobbe Number (W) given by:

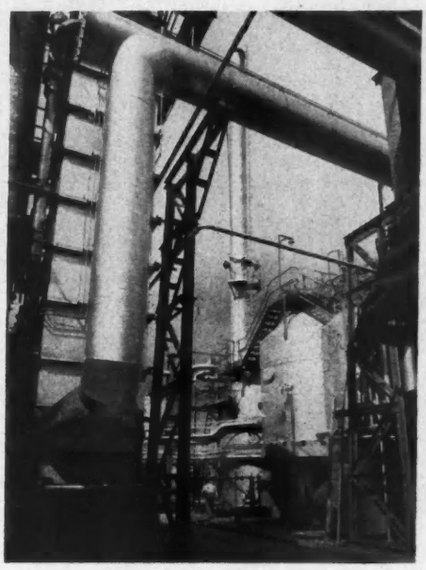
$$W = \frac{\text{Calorific value}}{\sqrt{\text{Specific gravity}}}$$

The calorific value is approximately proportional to the air required for complete combustion of the gas, so that the Wobbe Number can also be used as a measure of other properties of the gas.

The flame speed of a gas cannot easily be expressed as a single factor, since it varies with the proportions of gas and air in a mixture of them, reaching a maximum at about the theoretical proportion of air to gas. However, a flame speed factor (S) has been developed which can be used to compare the burning velocities of different gases. This factor is the maximum flame speed, as calculated for a particular gas, expressed as a percentage of the maximum flame speed of hydrogen in air.

It is difficult to measure flame speeds in absolute terms, and reliance is placed instead on the use of special test burners which measure a combination of the factors that are important. The Aeration Test Burner assesses the height of the inner cone to be expected on aerated burners in terms of an Aeration Number. The Non-Aerated Flame Height Burner measures the height of a non-aerated flame burning on a selected jet under standard conditions. If aromatic hydrocarbons are present in the gas a second luminous zone above the usual one is formed, and the height of this " benzene fringe " is an indication of the propensity of the flame towards sooting. The Reversion Pressure Test Burner assesses the tendency for a non-aerated flame to lift by measuring the pressure at which a lifted flame returns to the burner head.

The only completely satisfactory method of assessing the suitability of a given gas for the conditions obtaining in a given district would be to compare the results of actual tests of performance on a wide range of appliances. This would be extremely lengthy, and a considerable amount of work has therefore been carried out



in the Watson House Laboratories of the Gas Council whereby measurements of Wobbe Number and the various Test Burner Numbers can be used to predict the combustion characteristics of a given gas.[15, 16, 17]

The constituents of the gases discussed earlier in this paper can be divided into three groups: hydrogen, having a high Wobbe number and a very high flame speed; hydrocarbons, having high Wobbe number and low flame speeds; and carbon monoxide and inerts (nitrogen and CO_2) having low Wobbe numbers and low flame speeds. A preliminary idea of the likely performance of a gas can be obtained from the proportions of these groups it contains. Thus mixtures of hydrocarbons and inerts will give gases which will lift, which may give rise to incomplete combustion, or which may light back. Gases lying inside the limits necessary to avoid lifting, lighting back or incomplete combustion must contain a fairly high proportion of hydrogen.

Using these techniques, even before many of the new gases are actually being produced, it is possible to build up criteria for the behaviour of the gases when burnt in an appliance. A sorting of the gases into unsatisfactory, satisfactory and borderline types can be made, and the necessary steps to improve the performance of the unsatisfactory and borderline cases can be foreseen. These calculations are, of course, supplemented by actual tests with samples of the various gases and mixtures as and when they become available. In this manner, a picture of the effects of novel gases on the district can be built up, and there is no doubt that the mass of knowledge that has been collected by this research will prove to be of value in the working of a national gas grid.

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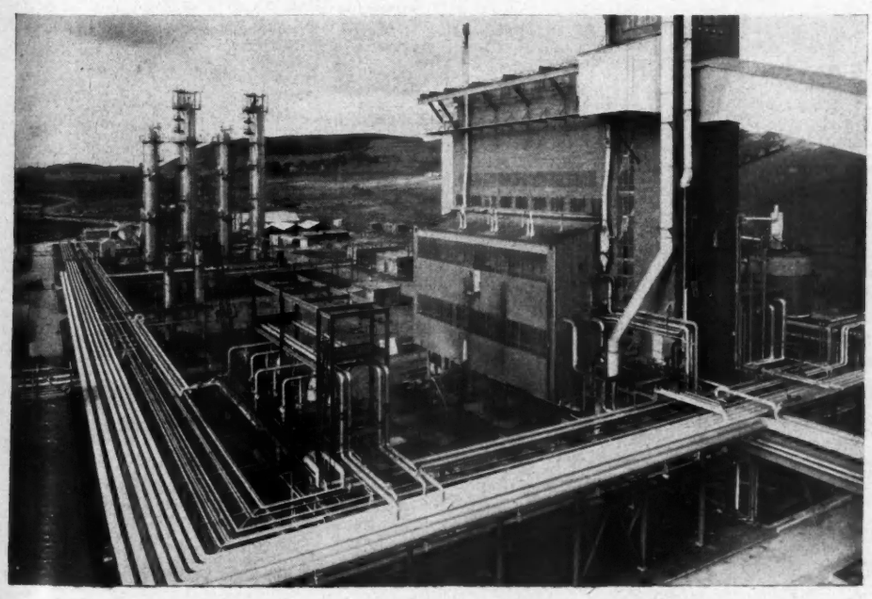

(Above) Plant at Romford, Essex, for the treatment of gases delivered by high-pressure pipeline from the oil refinery at Shell Haven.

(Left) Britain's first Lurgi high-pressure complete gasification plant, at Westfield, Fife, opened by Her Majesty the Queen on 27 June this year.

Electric Garden

"A FEATURE of this desirable residence is that the garden is fully wired for electricity." At the present time there are not many house agents' advertisements that would include the foregoing statement, but it may well be a standard insertion in the future if present trends continue.

Electric tools, and mowers in particular, have the great advantage over those driven by petrol engines that they are relatively silent. They have the disadvantage of having to have a trailing lead or of having heavy batteries that need recharging regularly. Battery mowers are now coming on the market and are finding some degree of popularity, but they have a long way to go. At the last Chelsea flower show a battery mower was shown on the EDA stand; it is available in two sizes, 12 in and 14 in. The former will run for about 1½ hours continuously on one charge and the latter for 2½ to 3 hours. For a mower, the weight of the batteries can be considered an advantage as it will give improved rolling performance. A luxury machine is the remote controlled mower made by H. C. Webb, described in ENGINEERING, 11 March, 1960, p. 372.

The mains-powered machine is free from the annoyance of running out of power but has the nuisance of the trailing cable. In a large garden the obvious answer is to run permanent wiring to strategic positions around the garden where the trailing lead can be plugged in. With such a system the scope of electricity in the garden is immediately increased enormously. All the small power tools based on the electric drill become usable, bringing hedge clipping, spraying, and sawing within easy reach. Admittedly, all these functions can be carried out using flexible drives from a petrol engine (whether on a mower or a cultivator) but the freedom of action is restricted to the length of the drive. A cable can be any reasonable length and does not have to be kept more or less straight.

But it is essential that any outdoor wiring should be done with professional skill. The dangers of corrosion and damp are not to be taken lightly, and in general the work should be done by a qualified contractor. The fittings also must be suitable for use outdoors; standard interior fittings will not give the required protection.

An electric version of the Sprite mower made by Ransomes, Sims and Jefferies Limited, was introduced recently. This has a 14 in cut and is driven by a ½ hp Hoover Mark 4 motor. The controls consist of a starting switch and a Glida-Mo clutch—the throttle of the petrol engine is of course eliminated. Instant starting is one of the appeals of electric mowers—even the best petrol engine occasionally has a day off for no apparent reason. It is claimed that with the Sprite electric, up to 500 sq. yd can be cut to a fine finish in 20 minutes.

The clutch lever operates a jockey roller on the belt drive from the motor to the roller, increasing the tension to take up the drive and releasing it to free wheel. If the cutting cylinder should strike an obstruction, the belt will slip and so afford protection from damage. The chain drive to the cylinder gives 64 cuts per yard. The bottom blade has a positive screw adjustment and the height of cut can be varied from ¼ in to 1½ in.

Most people know the peculiar delights of a garden on a summer evening and these can be enhanced by the careful use of concealed lighting. The illustration, supplied by the British Lighting Council, shows a garden in Chelsea. The use of well concealed coloured lights gives the effect of spaciousness and seclusion even in a heavily built-up area.

Again the emphasis must be on a proper wiring installation. The ordinary lamp holder is not safe against the ingress of damp, and weatherproof types must be employed. Toughened glass spot and flood lamps are now available which are specially designed for outdoor use. Rowlands Electrical Accessories Limited, R.E.A.L. Works, Birmingham 18, produce a range of weatherproof fittings designed for garden use. These include spot and flood units for projection lighting, and troughs and round-caps for beds and downwards light generally. An example of the last named is the Monkscap which is 24 in diameter and intended to house three filament lamps, which can of course be different colours to produce particular effects. The ¾ in supply conduit forms the central supporting pillar.

Concealed lighting can add greatly to the charms of a garden on a summer evening but the wiring and fittings must be competently installed and weatherproof.

The one important point in siting the lights is that the light source itself should not be visible. Thus it is useful to have the lights on reasonably long cables so that adjustment can be made after the main installation work has been carried out. Such an arrangement would also allow the effect to be varied some-what according to the seasons and to which flowers are in bloom. For safety the cables must be kept well out of the way of dogs, children and garden tools. A very pleasing effect can be obtained by mounting a flood above a door or window, controlled from inside, so that a night picture of the garden can be obtained by people seated within doors. Lighting also stimulates plant growth, as residents near street lamps have found.

The use of electricity for soil warming is another development of the electric garden. Primarily its use is for propagating frames but it can be extended for frost protection—even of the drive. Either low voltage resistance cables can be used or, alternatively, mineral insulated cables. Automatic watering is normally confined to greenhouses but it would seem to be possible also for use outdoors.

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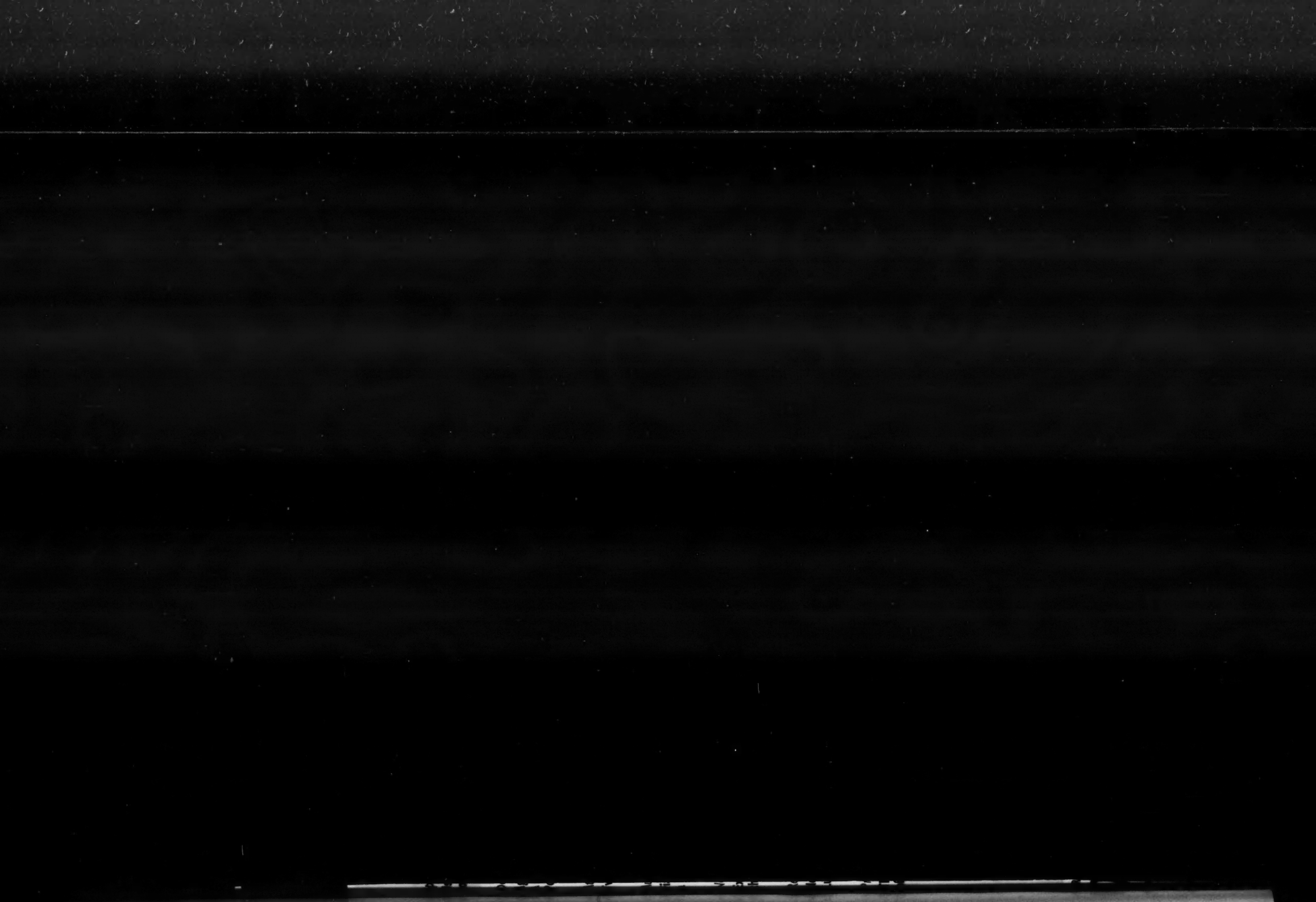
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